Knowledge.

With which is incorporated Hardwicke's Science Gossip and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

MAY, 1910.

EDITORIAL.

Owing to the fact that KNOWLEDGE is, for the time being, published later than the first day of the month, we are here enabled to pay our respectful tribute to the memory of His Majesty King Edward VII, whose unexpected death has plunged nearly the whole of the civilized world into mourning, and whose loss will be deplored deeply, and in a way that no formal words of sorrow can express.

It is not a fitting time to rejoice over any measure of success which may have crowned the efforts of those who are now responsible for KNOWLEDGE, to change it (from a weekly newspaper of the nineteenth century which by force of circumstances came to be published monthly, first at the price of sixpence and then of a shilling) to a twentieth century periodical of the class that its present price would suggest. We leave our readers to judge for themselves and merely say, while giving a list of some of those who have promised their help, that no effort will be spared to improve the magazine in every direction.

Mr. C. F. Chambers, J.P., F.R.A.S., whose books on the Sun and Stars are so well known, will for the present act as Astronomical Editor, while Mr. F. A. Bellamy, M.A., F.R.A.S., First Assistant, University Observatory, Oxford, has already given his help.

Professor F. Cavers, D.Sc., F.L.S., Professor of Botany at Hartley University College, Southampton, has become responsible for the Botany, while Dr. Dukinfield Scott, D.Sc., F.R.S., has in this number made good his promise to contribute. To these names we are glad to add those of Mr. Francis Darwin, D.Sc., M.B., F.R.S. and of Mr. G. Claridge Druce, J.P., M.A., F.L.S., Fielding Curator of Botany, Oxford University. The addition to the list of the name of Mr. F. W. Rudler, I.S.O., F.G.S., lately Curator of the Museum of Practical Geology, will be welcomed by all our readers, and in this connection we may mention Mr. Wintour F. Gwinnell, B.Sc., F.G.S.

The Zoological Editor will be Professor J. Arthur Thomson, M.A., of the University, Aberdeen. Articles may be expected from the Rev. T. R. R. Stebbing, M.A., F.R.S.—whose delightful writings will be familiar to old readers of KNOWLEDGE—Professor J. P. Hill, D.Sc., Jodrell Professor of Zoology in the University of London, and the Hon. Walter Rothschild, Ph.D., while Mr. Walter E. Collinge, M.Sc., F.L.S., has kindly promised to contribute a monthly column on Economic Biology.

It is almost impossible for one worker to deal adequately with a subject which bears on several sciences, hence as will be seen from the heading of the column dealing with Microscopy, a number of contributors, whose names are there set out, will be responsible for it.

It is intended that Physics and Chemistry shall be specially well represented, and with these and other subjects we shall deal in our introduction to the June number. We would further call special attention to Principal Miers' article on "Science and the Amateur," which is printed over-leaf.

It may be well to repeat the request that our readers should kindly furnish us with suggestions and criticisms and to ask that all communications should be addressed to the new offices:—42, BLOOMSBURY SQUARE, LONDON, W.C.

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SCIENCE AND THE AMATEUR.

By HENRY A. MIERS, M.A., D.Sc., F.R.S.

Principal of the University of London.

EARLY in the nineteenth century, the newly awakened interest in Science created a great demand for popular scientific books; the learned Societies attracted the instructed public, but cheap primers and entertaining books on the wonders of science were devoured by those who had no special knowledge. Excellent pioneer work was done by means of these popular and elementary introductions, for they kindled and kept alive an interest which spread very widely among persons who had received no scientific education or training.

At a later date, when science had found a place in education, there was no longer a need for the same type of book, and the latter part of the century witnessed the growth of the more accurate and detailed text-book which can only be really understood by those who have received some preliminary training: the scientific amateur had become a more learned person, and no longer required books of so elementary a character as an introduction to the subject in which he was interested; and it might be thought that at the present time the demand for popular books and magazines concerned with science had almost died out.

It must, however, be remembered that although the amateur is no longer ignorant of scientific facts or of the ideas which prevail among scientific men, he is in some respects in a worse position than the amateur of fifty years ago; because the amateur of that time was able to read and to understand the elementary text-book dealing with almost any science. Whereas, with the advance of specialism it is now becoming every day more difficult for the mere amateur to make a beginning in any subject without some orthodox training. It is, in fact, more difficult now for a student who is perfectly familiar with one branch of science to understand what is being done in other branches, than it was fifty years ago, when the ideas and the language were simpler.

The gulf between professionals and amateurs has been widened and deepened until it is more difficult for the amateur to bridge the chasm with any of the ordinary educational opportunities or books that are at his disposal.

I have had occasion more than once to state my conviction that there are in the country very many intelligent and instructed persons willing and anxious to take part in active scientific work who are deterred by the fact that such work seems to have passed more and more completely into the hands of professional scientific men, whose language is unintelligible to any but their brethren.

What these persons require is not books and magazines that will teach them a smattering of science, but a living literature which will put them into touch with the active work of more professional investigators. At present the scientific journal is too abstruse or too special, and is couched in a language which closes it to the comprehension of the general reader, though he may have learned a considerable amount of science in his school days; and the popular magazine article, or the article of the daily press, is usually too elementary and inaccurate to be of any real service.

The readers for whom a need has yet to be supplied are not the uninstructed unintelligent folk who will be satisfied with a sensational article or lecture, but the large public that has now grown up with an interest in science and a desire to understand what is being done by scientific workers; persons who are willing to devote some of their leisure to the study of science and to supplement what they learned at school by a knowledge of the work which is being carried on by the modern investigator and even, if it be possible, to co-operate with him. There is a need for a journal written for ordinary intelligent people who, without having received any special training, have yet a real knowledge of scientific principles and perhaps a considerable acquaintance with some one branch of science: a journal which will supply them with some information as to what is being done in Natural History and in the experimental sciences, and designed also to bring the professional worker into touch with those who are interested in his work and are willing and competent to assist him: through it he will perhaps have the opportunity of directing their labours, and so making them valuable collaborators in fields of research where such assistance is sorely needed.

It is in the hope that "KNOWLEDGE" may be brought to supply this need and to play some such part, that, at the request of my friend, Mr. Webb, I have written these somewhat fragmentary remarks by way of introduction to this number of the Magazine.

ARCTIC TERNS ALIGHTING FROM FLIGHT.

Illustrated from hitherto unpublished photographs

By W. BICKERTON, F.Z.S., M.B.O.U.

The accompanying pictures were obtained by Mr. W. Bickerton on the West Coast. The photographic plates have not been touched up in any way, and the reproductions will speak for themselves.

FIGURE 1. The Arctic Tern (*Sterna macrura*). Side View.

FIGURE 2. The bird seen from the front.

FIGURE 3. Another example looked at from behind. The nest, containing two eggs, can be seen to the right of the bird, just where grass and rock meet.

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Portrait of Edmund Halley.

From an engraving by G. White after Sir G. Kneller's painting.

EDMUND HALLEY.

By T. A. BELLAMY, M.A., F.R.A.S.

Not long ago an article upon Halley appeared in " KNOWLEDGE,*" and considering the interest which attaches to his work it has been thought of value at the moment to deal more fully with the life of this celebrated astronomer. The present writer was quite unaware of the existence of the article mentioned until the following pages were in type.*

Who was Edmund Halley?

Edmund Halley, the son of a wealthy soap-boiler, a citizen of London, was born at Haggerston, then a village near London, on October 29th, 1656; his early education was at St. Paul's School, and his father then sent him to Queen's College, Oxford, as a commoner in 1673, where he was distinguished both as a classical and mathematical scholar.

At the early age of nineteen Halley came to notice by his work on the determination of the aphelion and eccentricity of the planets by a direct method invented by him. He studied Mathematics and Astronomy assiduously, not only as a library student but by applying himself also to instrumental observations. He obtained such instruments of the period as his means would allow and scarcely let a single fine night pass without using them on the sky; he soon detected that the existing tables made the mean motion of Saturn too fast and that of Jupiter too slow, and in order to correct or improve these tables, he considered that it was necessary to make a good star catalogue. This deviation from the tables was amply confirmed in later years. Halley knew that Flamsteed, Helvelius and Cassini were already observing stars with the object of improving the star places, and he thought that instead of competing with them he would turn his attention to the southern hemisphere, where no satisfactory and systematic observations had hitherto been recorded, if we omit those by Tycho Brahé; so that his work would be supplemental to the northern observers' and corrective of Tycho's. There were some observations by Houtman (in Sumatra), but of these Halley had a poor opinion.

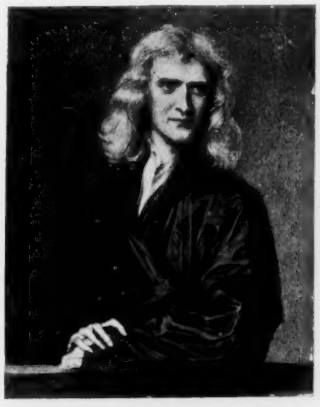

FIGURE 1.

Portrait of Sir Isaac Newton.
After the painting by Kneller.

FIGURE 2.

Portrait of J. Helvelius.

At the age of twenty, this man, vigorous in mind and body, undertook a purely scientific journey to the Island of St. Helena. In those days, ocean travels were of a long and arduous character and not without danger. Some advised Halley to go to Rio de Janeiro, others to the Cape of Good Hope, where La Caille, about one hundred years later, did such excellent Star-catalogue work; but Halley decided upon St. Helena, then the most southern possession of England. His father provided him with the necessary funds, and he was favourably recommended to the royal patron of Astronomy, Charles II. The East India Company, which had the Island under its control, gave Halley every facility; and, after a voyage of three months, he was safely landed there with a sextant of five and a half feet radius, similar to that of Flamsteed, and an object-glass of twenty-four feet focal length.

Unfortunately, the climate for the year he was there, 1677, was so bad that he records that he was only able to observe, with difficulty, three hundred and sixty stars, that at one period of two months he could only obtain two observations, and that the duration of a clear sky was seldom as much as one hour: enough to daunt most astronomers in much less time than a year.

Halley was able to record some other observations than of stars. In 1677, on October 28th (O.S.) he observed the Transit of Mercury across the Sun's disk, being the first to observe and record this phenomenon, between 9.28 a.m. and 2.42 p.m., and from it he deduced that the Solar Parallax was 45″—decidedly wide of the mark; but one must allow great latitude on account of the poor quality of the instruments of that period and the inadequate materials for basing such work. He came to the conclusion, though we apparently owe the original suggestion to James Gregory—Halley may or may not have known this—that under suitable conditions it would be possible to determine the parallax of the Sun from such transits, and if Venus were substituted, a more accurate result would be obtained: judging by the results of 1874 and 1882 the use of these two major planets is now superseded by more efficient means: he returned to this subject in 1718. Halley was now twenty-one years old. He also predicted the transits of Mercury to the year 1799. On his voyage to St. Helena, he noticed the retardation of

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the pendulum when approaching the Equator. He searched for the parallax of the Moon; this idea, though a good one, was not new. He did not persevere in these observations, not having, previous to his departure, acquainted European astronomers with his desire for similar observations for comparison. La Caille, much later, carried out this scheme, when at the Cape, with much success. Halley's method at the same time afforded the determination of the Moon's inclination. Halley had already made researches on the Lunar Theory, a branch of Astronomy then in a most neglected state, and yet one that was very necessary for finding longitude in the sailing and pre-chronometer days. He flattered himself that his ideas approximated to the truth more than the theories of others. As his views were favourably received he undertook to make every effort to improve that theory: he was then about twenty-two years old. Halley returned from his expedition in 1678, and by command of the King he was given a full M.A. degree at Oxford, and was elected a fellow of the newly-formed Royal Society. He at once set about the production of his catalogue of three hundred and sixty stars, and it was published in 1679 both in London and Paris. As was the fashion of that period the text is in Latin and the title, beginning with *Catalogus stellarum australium*, is very long, having sixty-one words. Halley, in this catalogue, made certain notes indicating variability in the magnitudes of some of the stars in Ptolemy's catalogue, and asked himself if the change was due to time. He also, out of compliment to his royal patron, Charles II., appropriated some stars (about fifteen) from the constellation of Argo II. and formed a new one, which he called *Robur Caroli* (Royal Oak) (*See* Figure 3), but he was reproached for this especially by Flamsteed who, in his catalogue of three thousand stars, wrote severely about innovators.

Not very long after this, the subject of our article went on a journey to Dantzic to smooth a long-standing quarrel between Hooke and Helvelius, and at the end of 1682 he married Mary, the daughter of Mr. Tooke, an auditor of the Exchequer, and his married life, for the long period of fifty-five years, was a happy one. He went to live at Islington, and made lunar observations in connection with his researches on lunar longitude. Halley first suspected that the anomalous irregularities of the two planets, Jupiter and Saturn, were due to their mutual attraction. He attempted to determine the magnitude of the inequality for each planet by a comparison of the ancient and modern observations. He also discovered the remarkable inequality of the Moon's mean motion, due to the variation of the Earth's eccentricity from an examination of the old eclipses recorded by Ptolemy and Arabian Astronomers, and he was induced to suppose that the motion was subject to a continual acceleration; this phenomenon he first alluded to in 1693, but appears to have made no attempt to confirm his suspicions, and they were not confirmed until 1749, in a paper communicated by Dunthorne to the Royal Society, though Halley persistently observed the moon for many years.

Though these investigations are not unworthy of the man, they rather sink into insignificance by comparison with Halley's other and later work; foremost of which were his connection with Newton's Principia and the important corollary to that treatise by his investigations upon cometary orbits.

It is generally understood that Newton did not begin or intend to write a treatise embodying his views on Gravity as in the Principia until after Halley's visits in August and at the end of 1684. From existing letters it seems certain that, by these visits and the letters, Newton was not only induced by Halley to publish his investigations but was even urged and encouraged to continue them. In the preface to the Principia, Newton expressly states that it was to Halley's solicitations that its publication was due. And in Pemberton's edition of 1726, with the preface by Newton and dated January 12th, it is stated that it was Halley's discourse (1686) that engaged Newton to resume again the consideration of this subject and gave occasion to his writing the treatise. As a prelude, Halley gave, at the meeting of the Royal Society in 1686, April 21st, a discourse concerning Gravity, and mentioned (Phil. Trans. 1686, pp. 6-8) his "worthy countryman, Mr. Isaac Newton, who had an incomparable Treatise of Motion almost ready for the press." A week later the MS. arrived at the Royal Society; on May 19th it was ordered to be printed, but owing to the want of funds it was shelved. In Birch's History of the Royal Society, IV. p. 486, it is recorded that on June 2nd it was ordered "that Mr. Newton's book be printed and that Halley undertake the business of looking after it, and printing it at his own charge; which he engaged to do." So the Society was relieved of its obligation by Halley's generosity. During the course of printing, a dozen or more letters passed between Newton and Halley, and owing to the delay in printing two separate printers were employed (Halley's letter of 1687, February 24th). Halley sent Newton the first sheet in proof for approval of the style of type for correction, and he was at considerable trouble in the details of type, as in all other matters (letter of 1686, June 7th). On June 20th of that year Newton replied, and at the end of a long letter concerning Hooke, wrote "The proof you sent me I like very well." There was some delay by Newton in writing his third book, but this was profitable to science. Newton required various astronomical observations and data, and much of this he obtained from Flamsteed, and was ably assisted by Halley. When referring to the exact title which should be adopted for the book he concluded his letter with these words, "But, upon second thoughts, I retain the former title" (that by which it is known). "Twill help the sale of the book, which I ought not to diminish now 'tis yours."

In 1679 and 1680 Newton had had correspondence with Hooke, owing to Hooke's presumptuous

claims. Newton declined further correspondence. After Halley had brought the matter before the Society, in 1685, Hooke renewed his attacks. So strong were Newton's intentions, as evidenced by the correspondence in 1686 with Halley, that he said he would suppress the third book rather than be falsely accused by Hooke of plagiarism, have his honesty attacked, and be involved in disputes. "Philosophy," Newton wrote, "is such an impertenently litigious lady that man had as good be engaged in lawsuits as to have to do with her." Halley was much to the fore in disproving the claims of Hooke, who was ever ready to lay claim to every scientific discovery of his time, and in a letter of June 29, 1686, so successfully did Halley appease Newton's anger when he appealed to Newton's good nature, explaining that few believed Hooke's claims, knowing the presumptuous character of the man, and begged him not to deprive science of the third book, that Newton gave way to Halley's wishes. We thus realise that Halley has no small share in the production of such a book, and the honour indirectly due to Halley is not greatly inferior to that accorded to Newton. Where would have been the Principia or the investigations contained therein but for Halley? On March 7th, 1686/7,

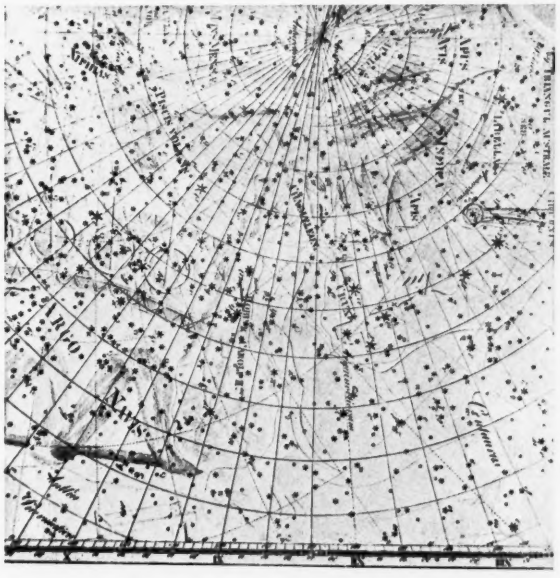

FIGURE 3. Bode's Map

Showing the position of Halley's adopted constellation. *Robur Caroli II.*

Halley wrote to Newton when the MS. of the second book was received and asked for the third, "I will endeavour by a third hand to get it all done together" (Halley already had two independent printers working at the first and second books) "being resolved to engage upon no other business till such time as all is done: desiring herby to clear myself from all imputations of negligence in a business wherein I am much rejoyced to be any wais concerned in handing to the world that that all future ages will admire." Again on March 14th, he wrote referring to the eighteenth sheet . . . "By reason of the extraordinary trouble of the last sheet . . . I have not been wanting to endeavour the clearing of it of errata" . . . . . and on July 5th, 1687, he wrote "I have at length brought your Book to an end, and I hope it will please you" . . . He offered to present copies of the book to certain

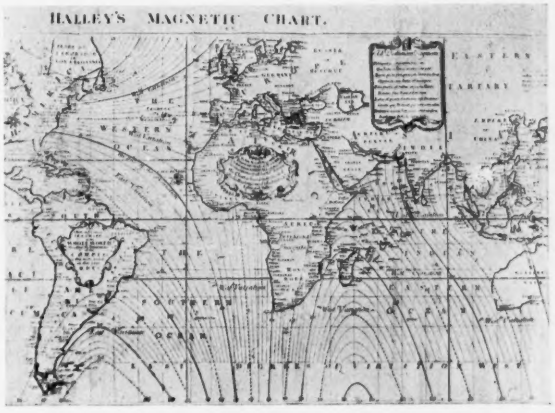

FIGURE 4. Halley's Magnetic Chart

Showing the curves of variation in different parts of the earth.

people in London and the letter continues: "I have sent you to bestow on your friends in the University twenty copies, which I entreat you to accept"; then he mentions that he is sending forty more copies for Newton to place for sale at booksellers, and as to the price he says "I am contented to let them go halves with me." This is a strong proof of the generosity and high principles of Halley.

In that period printing was not an inexpensive luxury, and Halley, who had been brought up as a rich man's son, had as yet no profession. Having married in 1682 he had a wife and family dependent upon him, and to increase his difficulties his father died in 1684, which event reduced him to great straits; so much that on January 27th, 1686, he gratefully accepted the position of clerk and assistant to the Secretary of the Royal Society at £50 a year; this post he held till 1698. It has been shown that he made himself entirely responsible for Newton's Principia a few months later, and as the edition was probably only two hundred copies, and these were offered for sale (wholesale) at 5s.; he must have lost a great deal of money over it. Yet his interest was not limited either to his correspondence and visits to Newton. For, in the Phil. Trans. XVI. p. 291, 1687, Halley gave a review of the book intending thereby to draw attention to the new hypotheses and discoveries. In 1696 he was appointed Controller of the Mint at Chester.

In 1698, August 19th, another phase of Halley's work was begun. He received an official appointment from the Admiralty to take charge of one of

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His Majesty's ships on the active list, to take the ship to the South Atlantic Ocean and carry out the commission, as a copy of the original Minutes of the Admiralty shows :—

"Whereas his Majesty has been pleased to lend his 'Pink the Paramour' for your proceeding with her on an expedition to improve the knowledge of the Longitude and variations of the Compasse, which shipp is now completely Man'd, Stored, and Victualled, at his Majesty's charge for the said Expedition: you are therefore hereby required and directed to proceed with her according to the following instructions :—

"You are to make the best of your way to the southward of the Equator, and there to observe on the East Coast of South America, and the West Coast of Africa, the variations of the Compasse with all the accuracy you can, as also the true situation both of Longitude and Latitude of the Ports where you arrive.

"You are likewise to make the like observations at as many of the islands in the seas between the aforesaid Coasts as you can (without too much deviation) bring into your Course; and, if the season of the year permit, you are to stand soe farr into the South till you discover the Coast of the Terra Incognita, supposed to lie between Mongolan's Straits and the Cape of Good Hope, which Coast you carefully lay down in its true position. In your return home you are to visit the English West India Plantations or as many of them as conveniently you may, and in them make such observations as may contribute to lay them down truely in their Geographicall Situation. And in all the Course of your voyage you must be carefull to omit no opportunity of noting the variation of the Compasse, of which you are to keep a Register in your Journal.

"You are, for the better lengthning out your Provisions, to put the men under your command when you come out of the Channel to six to four men's allowance, assuring them that they shall be punctually pay'd for the same at the end of the voyage.

"You are during the Term of this Voyage to be very carefull in conforming yourself to what is directed by the Generall Printed Instructions annexed to your Commission, with regard as well to his Majesty's honor, as to the Government of the Shipp under your command, and when you return to England, you are to call in at Plymouth, and, finding no order there to the contrary, to make the best of your way to the Downes, and remain there till further Orders: Giving us an Acct of your arrival."

The results achieved during the voyage were a fine series of observations on terrestrial magnetism as far as 52 degrees S. in which his theory of magnetic variation and his suggestion of the magnetic origin of the aurora were both modified and supported. These observations of the compass were published by the Admiralty in a "General Chart of the Variation of the Compass" in 1701; latitudes and longitudes of numerous places, tidal and other observations were made; but, mutiny having broken out on board, the expedition appears to have been curtailed in time, as Halley had returned in the following June as the following document shows :—

"Whereas wee have rec^{d} a Letter from Capt^{n} Halley, Comand^{r} of his Majestie's Vessell the Paramour Pink, complaining of Lieut. Harrison, the officer which acts as mate and Lieut. of the said Pink, a copy whereof comes inclosed, which complaint Wee think fitting should be inquired into at a Court Martiall upon her arrival in the Downes: You are therefore hereby required and directed to cause the same to be strictly inquired into and tryed at a Court Martiall accordingly, for holding whereof you are empowered by our late Warrant to you.

"And, when the Court Martiall shall be over, you are to order the Comander of the said Pink forthwith to repaire with her to Long-reach, and there hasten the putting ashore her Guns, Stores, and Provisions, and from thence to proceed to Deptford, where she is to be paid off and laid up."

"Dated &c. the 29th of June '99.

BRIDGEWATER.
HAVERSHAM.
"By command, &c. ROBERT RICH.
JOSIAH BURCHETT." GEORGE ROOKE.
DAVID MITCHELL.

At a later period in 1701, Capt. Halley was again commissioned by royal command to undertake a survey of the English Channel, both the coast line and tides; a fine map was produced by him in 1702. This is the Commission :—

"Whereas his Majesty's Pink the Paramour is particularly fitted out and Putt under your Command that you may proceed with her and observe the course of the Tydes in the Channell of England, and other things remarkable: You are therefore hereby required and directed to proceed with the said vessell, and use your utmost care and Diligence in observing the course of the Tydes accordingly, as well in the Midsea as on both Shores. As alsoe the Precise times of High and Low Water, of the Sett and Strength of the flood and Ebb, and how many feet it flows, in as many and at such certain places as may suffice to describe the whole. And whereas in many places in the Channell there are Irregular and halfe Tydes, you are in a particular manner to be very careful in observing them.

"And you are alsoe to take the true bearings of the Principal head Lands on the English Coast, one from another, and to continue the meridian as often as you conveniently can from side to side of the Channell, in order to lay downe both coasts truely against one another.

"And in case during your being employed on this service any other matters may occur unto you, the observing and Publishing whereof may tend towards the security of the navigation of the subjects of his Majesty, or other princes trading into the Channell, you are to be very carefull in the taking notice thereof, and when you shall have performed what service you can, with relation to the particulars beforementioned, you are to returne with the Ship you command into the River of Thames, giving us from time to time an account of your Proceedings.

"Dated this 12 June, 1701.

PEMBROKE.
DAVID MITCHELL.
GEORGE CHURCHILL.

"By command &c. J. BURCHETT"
To Capt^{n} Edm^{d} Halley.
Comd^{r} of his Majesty's
Pink the Paramour.

To be continued.

THE FAIRY SHRIMP.

Chirocephalus diaphanus.

By G. W. PYMAN.

With Illustrations by Charles Sillem, F.L.S.

ON March the 4th last, I had the good fortune to find a number of the very rare crustacean *Chirocephalus diaphanus* swimming in some flood-water on Eton Wick Common. The animals very readily attracted my attention owing to the incessant movement of their phyllopods, and their very bright colour.

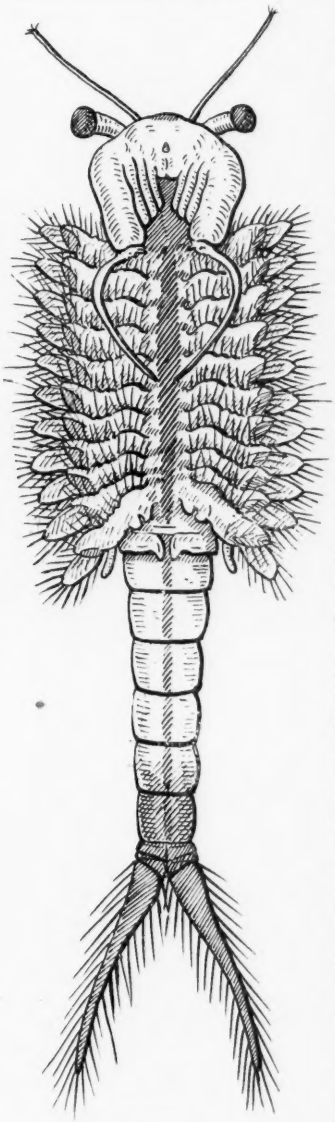

FIGURE 1.
A male *Chirocephalus diaphanus.*

At first sight I could not remember having ever seen anything like them before, until I thought of a spirit specimen of *Branchipus* which we had in the laboratory at Eton College. I managed to catch two or three specimens, with my hand, which I took to Mr. M. D. Hill, and he informed me that I had found *Chirocephalus diaphanus*, which is closely allied to *Branchipus*. As Mr. Hill had never seen them alive before, he was anxious to catch as many individuals as possible in order that he might have an opportunity of observing the habits of these interesting creatures. During the afternoon we were able to secure between twenty and thirty specimens. Nearly all of these were placed in some aquaria which we had in the laboratory, while the few that remained were kept in a glass dish by themselves. During the night those in the aquaria suffered severely from the attacks of water beetles, which devoured practically the whole number. Fortunately, those in the dish by themselves all lived, and during the next day I found several more—which I placed with them.

Although the area of the piece of water in which the crustaceans occurred was at least twenty-five square yards in extent, the majority of the specimens occurred at one edge, in six holes made by the feet of horses or cows which had come down to the pool to drink, that is to say the *Chirocephalus* were practically isolated from the main body of water in some shallow puddles.

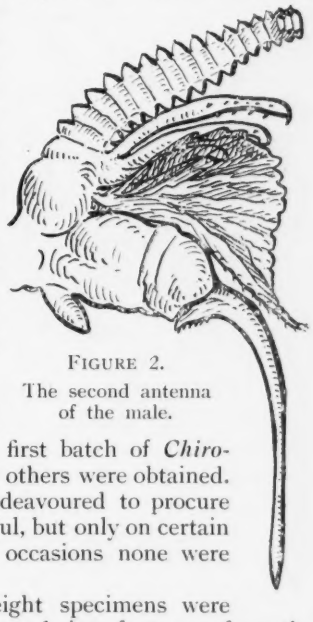

FIGURE 2.
The second antenna of the male.

During the period that immediately followed the finding the first batch of *Chirocephalus* at Eton, a few others were obtained. Some of those who endeavoured to procure examples were successful, but only on certain days, while on other occasions none were to be seen.

A fortnight later, eight specimens were collected from a small pond sixty feet away from the original place, but since that time I have not seen, or heard of one, being taken.

The manner in which these creatures turn up suddenly in such small and temporary collections of water is very mysterious, and the only suggestion which one can make is that they are either carried on the feet of some water bird or brought down the river during flood season.

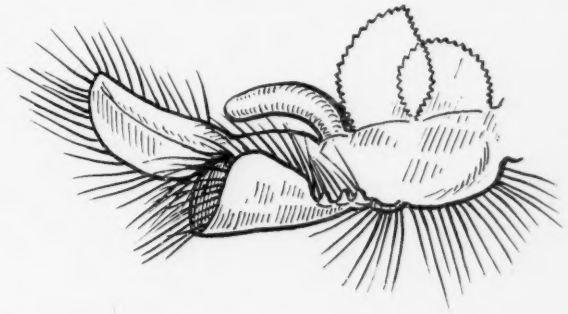

FIGURE 3. One of the ordinary swimming feet or phyllopods.

For the benefit of those who are not familiar with the Phyllopods it may be said that they belong to a

very primitive order of the Crustacea; and for the same reason a short account of *Chirocephalus*, called from the extreme beauty of its appearance and movements—the fairy shrimp, is here given.

The females are about an inch and three-quarters long, the males being slightly larger. The colour of the latter is a beautiful pale green, while the females are of a greenish brown. Both sexes have two red styles projecting from the telson and in the females these were mostly broken, a fact which it seems difficult to explain. The males are far more rare than the females, a characteristic of the Phyllopods generally. The eyes are supported on unjointed stalks.

There is no carapace and the appendages are typical of the Phyllopoda. The one striking character, is the second antenna in the males, which is considerably modified to form a clasping organ. (*See* Figure 2.) It consists of a jointed portion which is directed backwards, and an inner part consisting of one large and four small cylindrical lobes and a lamella. These are coiled up except when in use.

The mouth parts are very simple, the first maxilla being a triangular plate with a biting edge and the second, a simple oval plate. The thoracic appendages consist of eleven pairs of phyllopods performing both respiratory and locomotive functions.

The animals seem more active at night than during the day, especially under the influence of artificial light. I often watched them feeding on the filamentous algae, and also saw the females deposit their eggs. The animals do not appear to be very long-lived for at the time of writing I have only three specimens living.

Chirocephalus is very seldom found in this country and records of its appearance, though they date back to 1820, are not very abundant. During recent years it has been recorded from a pond between Claygate and Oxshott by Mr. Scourfield. It has also been noticed by Miss Kate M. Hall, who found it in a pond near the Gibbet at Hindhead. Mr. E. E. Austin, of the British Museum (Natural History), also came across it in numbers in cart ruts and small pools in Devonshire, and it seems to occur more frequently in that county and Cornwall than in any other part of the British Isles.

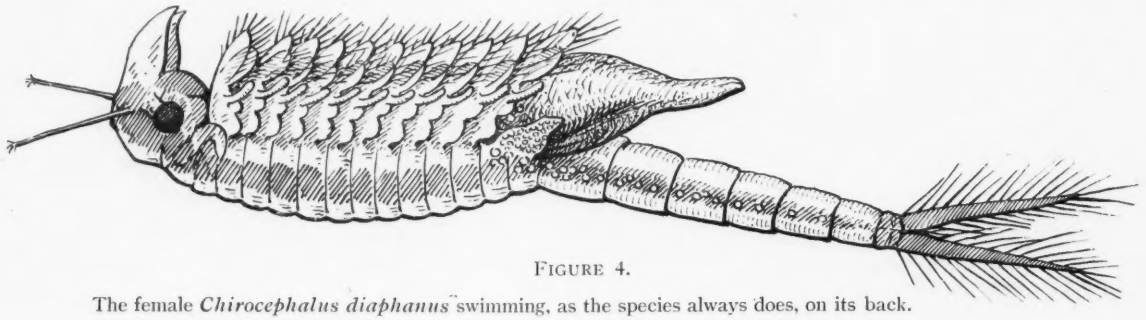

FIGURE 4.

The female *Chirocephalus diaphanus* swimming, as the species always does, on its back.

It has been bred by the Rev. T. R. R. Stebbing and Mr. Robert Gurney from mud taken from dried-up ponds in Surrey and at Oxford, in which the eggs had been deposited.

A very interesting account of the occurrence of *Chirocephalus* on the Continent is given by Julius Budge in a German work *(Verhand. Naturhist. Verein. Preuss. Rheinlande.)* dated 1846, in which the sporadic nature of its appearance is described and discussed.

The pond from which I took the specimens is now dried up, and it will be interesting to watch it again after the next flood and notice if *Chirocephalus* again appears.

THE SELBORNE SOCIETY.

The Selborne Society, of which the late Lord Tennyson was, and Lord Avebury now is, President, has recently been developing its work and increasing its activities. During last year it acquired new offices in order to form a home for its Library and to provide Reading and Committee Rooms. It also inaugurated a series of central lectures in the Theatre at Burlington Gardens.

The Summer Excursions, which are held on every Saturday during the season, have now begun, and the Annual Meeting, at which a series of lantern slides illustrating the successful work that is being carried on in the Bird Sanctuary will be exhibited, has been arranged for June 17th.

It is hoped that a longer series of lectures will be organised in the autumn and winter months in addition to the visits which are paid on alternate Saturdays to places of interest during the same period.

In all these ways an endeavour is being made to promote the study of Natural History and Archaeology which should be the primary object of a body which perpetuates the memory of Gilbert White of Selborne. The Society, however, continues also to pay special attention to the protection of plants and animals and to the amenities generally while seeking in every way possible to co-operate with other Associations that do similar work.

XUM

THE EARLIEST FLOWERING PLANTS.*

By DUKINFIELD H. SCOTT, M.A., LL.D., F.R.S.

President of the Linnean Society of London.

ALL students of Palaeontology are aware of the complete and apparently sudden change in the character of the Flora, which ensued in Upper Cretaceous times, when the antique vegetation, with Conifers and Cycads as the highest groups, gave place to an essentially modern Flora, in which our ordinary families of Flowering Plants prevailed, such as catkin-bearing trees, Planes, Maples and relations of the Tulip tree.

From a photograph *by C. Henwood.*

FIGURE 1. *Stangeria paradoxa.*
A Male plant bearing several cones. Note the fern-like foliage. Victoria House, Kew

The present article is concerned with the older type of Flora, which lasted with but little change from the early days of the Secondary Period onwards and still remained dominant in the Lower Cretaceous age, though destined so soon (geologically speaking) to give place to the modern forms of vegetation. The time has been suitably called: "The Age of Reptiles," and the portentous Saurian monsters, that then walked the earth, so far as they were herbivorous animals, found their sustenance in the strange and coarse vegetation, which we are attempting to sketch.

Of what kinds of plants was the Flora of the age of Reptiles composed? Leaving the lower plants: Fungi, Seaweeds, Mosses and so on, out of account (for we know little about them) the vegetation of those days was made up of spore-bearing plants on the one hand, including great numbers of Ferns, a good many Horse-tails and a few Club-mosses, and of Seed-bearing plants on the other, chiefly Conifers and the great group, commonly called Cycads. So far as we know, Dicotyledons and Monocotyledons were entirely absent until the later Cretaceous times. The Conifers were, many of them, nearly allied to the Puzzle-monkeys (*Araucaria*), Pines and

FIGURE 2. *Cycas revoluta.*
The Centre of a female plant, showing the rosette of hairy, leaf-like carpels, bearing the seeds on their margins. Palm House, Kew.

*Based on a Presidential Address given to the South-Eastern Union of Scientific Societies at their Winchester Congress, 1909.

Cypresses of our own times, but together with these familiar forms there were many plants related to the Maiden-hair tree *(Ginkgo)*. This tree is now an absolutely isolated species, possibly wild on the mountains of Western China, but for the most part only preserved by man, especially in the gardens of Buddhist temples in China and Japan, whence it has long been introduced into Europe.

The group, however, in which we are immediately interested, is that of Cycads; all students of geology are aware that plants classed under this name were a great feature of the Jurassic and Wealden landscapes; the real nature of the Mesozoic Cycads, however, is probably less familiar, for it has only been cleared up during the last three or four years, and our accurate knowledge is still limited to one family.

The name Cycads, which we commonly apply to these Mesozoic plants, is taken from the small family, Cycadaceae, now living, which is itself not very well known, except to botanists, though one or two species are fairly common in cultivation. A magnificent collection of Cycads, some of the plants more than a century old, is one of the glories of the Palm-house at Kew. The family is now a very small one, embracing nine genera, with perhaps a hundred species, which belong to the tropical and sub-tropical regions of the old and new worlds.

FIGURE 3. *Cycadeoidea (Bennettites) Marylandica.*

The earliest described American fossil Cycad. Nearly thirty young fruits are marked in the present view by the groups of bract-scars inserted between the leaf-bases about quarter natural size. (After Wieland).

Reproduced, by kind permission, from "Studies in Fossil Botany."

Of the nine genera, one: *Cycas* is common to Asia and Australia; two: *Macrozamia* and *Bowenia* are Australian; two: *Encephalartos* and *Stangeria* are South African, and four: *Zamia*, *Ceratozamia*, *Dioon* and *Microcycas* are American, the last-named having only been found in the island of Cuba.

A few species of *Cycas* and the one species of *Microcycas* attain to the stature of trees. In the majority of the Family, the stem remains short, though often reaching a great thickness. The large pinnate leaves suggest those of Palms, a deceptive resemblance, which has led to the inappropriate name, Sago-palms being applied to the group. Some of the species do yield Sago, so that part of the name may pass muster.

A more interesting resemblance is that between the leaves of the African *Stangeria* and the fronds of a Fern, a resemblance so close that it led to *Stangeria* being included in the Fern-genus, *Lomaria*, before its cone was known. (*See* Figure 1.)

There is evidence from Palaeozoic fossils that a real affinity exists between Cycads and Ferns.

In recent Cycads the sexes are always on distinct plants. The male fructification in all cases forms a cone (*See* Figure 1.); each stamen or scale of the cone bearing on its lower surface a number of pollen-sacs, arranged like the sporangia of a Fern in groups or sori. In all the genera but one, the female fructifications are likewise cones, each scale bearing two seeds—which often grow to an enormous size—on its edges.

In the genus *Cycas*, however, no special cone is produced; the leaf-like carpels, bearing from two to six seeds each, grow directly on the main stem, like the ordinary foliage leaves, (*See* Figure 2.) a simple arrangement unknown in any other living seed-plants. Though *Cycas* is, in this respect, the simplest of the family, the whole group is more primitive than other seed-bearing plants.

As the Japanese botanists first discovered, twelve years ago, Cycads and the Maiden-hair tree alone among living seed-plants are fertilized, like Ferns, by actively swimming cells—the spermatozoïds.

At the present time, of all the vascular plants (i.e. all plants above the rank of Mosses) the Cycads scarcely amount to one species in a thousand.

In Jurassic and Wealden days one in every three was a Cycad.

If Cycads existed now in the same proportion to the whole Flora as they did then, there would be between thirty and forty thousand species of them instead of the poor hundred or so which represent the class to-day.

The few which survive are now limited to certain

places in the warmer parts of the World and are nowhere very abundant—in the old days they spread over the whole world, abounded in our own country and extended to the Arctic regions in Greenland and Siberia.

If we could see England (then a part of the Continent) as it was in those days, instead of grass pastures we should find the country overgrown with these tropical-looking Cycads—a vegetation almost as strange as the animals that browsed upon it. Of the remains which have come down to us, the leaves and trunks resemble those of living Cycads. (*See* Figure 3.) In the case of some of the leaves the resemblance is quite close, so that we have the genera: *Cycadites*, *Zamites*, *Dioonites* named after the recent types.

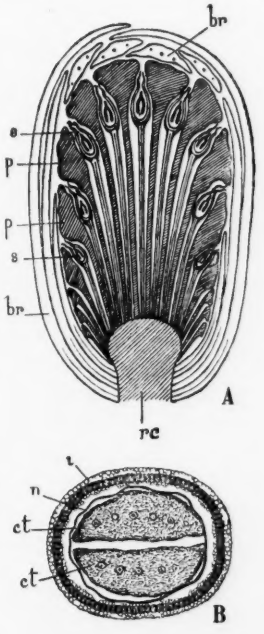

FIGURE 4.
Bennettites Gibsonianus.

A. Diagram of fruit in longitudinal section; *rc*, receptacle; *br* bracts; *s*, stalked seeds; the dicotyledonous embryo indicated in each; *p*, scales between the seeds forming a pericarp. About twice the natural size.

B. Transverse section of a seed; *i*, seed-coat; *n*, inner membrane or nucellus; *ct*, the two cotyledons of the embryo, with their vascular strands. Enlarged about twelve times.

Reproduced, by kind permission, from "Studies in Fossil Botany."

The leaves, however, are deceptive guides, for we now know that *Zamites* and *Dioonites* were not true Cycadaceae, though allied, while the Cycas-like leaves have also fallen under suspicion. Some of the trunks bear a close outward resemblance to those of the recent family, but when their structure has been examined, some differences have revealed themselves. Fine specimens of the trunks have been derived from the Wealden of Sussex and of Brook Point in the Isle of Wight. *Bucklandia*, from the former, much resembles, in its external features, the stem of a recent *Cycas*, while *Bennettites Saxbyanus*, from Brook, is a petrified stem, beautifully exhibiting the internal structure, which is simpler, as regards the course of the vascular strands, than a modern Cycadean stem.

The best evidence of the relationship of plants is drawn from their fructifications. Fortunately there are a great many cases in which well-preserved reproductive organs have been found in the fossil Cycads, often in connection with the stems that bore them.

Strange to say, these fossil fructifications very rarely bear any resemblance to the simple cones of living Cycadaceae—there are a few cases of the kind, but in the immense majority, the Mesozoic fructifications have proved to be far more complicated and more like the flowers of the Angiospermous Flowering Plants of later times.

In fact the Cycads of the Mesozoic period were not, as a rule, members of the same family as the recent Cycadaceae, though they belonged to the same class in a wide sense—they were on the whole far more advanced plants, worthy to have been the immediate forerunners of the modern Flora.

The first fossil in which the structure of the reproductive organs was made out, was the now famous *Bennettites Gibsonianus*, found in 1857 in the Isle of Wight at Luccombe Chine. This is in some respects one of the best preserved fossils known, exhibiting both vegetative and reproductive structures in remarkable perfection.

The habit of these plants was like that of the short-stemmed Cycads of the present day, but the fructifications were borne laterally on the stem in considerable numbers, between the bases of the leaves. (*See* Figure 3.)

In the case of *Bennettites Gibsonianus* the fructifications were found in the stage of ripe fruits of complex structure. (*See* Figure 4, A.) The seeds contain well preserved embryos with two cotyledons; these are the only fossil plants in which the embryo has been found. (*See* Figure 4, C.) The seeds, unlike those of any other known Gymnosperms, were practically "exalbuminous," the embryo filling the seed completely.

FIGURE 5. *Cycadeoidea dacotensis.*

Longitudinal section of a bisexual flower-bud; *s*, the incurved stamens, bearing numerous pollen-sacs; *o*, central receptacle, bearing the ovules; *a*, broken edges of the bracts—(*r*); *l*, leaf-bases; *c*, cortex of trunk; *t*, vascular strands supplying the flower. About two-thirds natural size. (After Wieland).

Reproduced, by kind permission, from "Studies in Fossil Botany."

The structure of the fruit, with its highly organised seeds enclosed in a pericarp, (*See* Figure 4, A.), was sufficiently remarkable, but the whole story of the flower was only revealed when the American fossil-botanists began to examine their magnificent material.

It is true that one European specimen, investigated by Count Solms-Laubach, had already afforded evidence that stamens and pistil were contained in the same flower. This specimen was a remarkable one in other ways, for it was found while excavating an Etruscan cemetery at Marzobotto near Bologna and appears to have been placed on a tomb as an

object of reverence—a sentiment with which every fossil-botanist will sympathize. There is evidence, however, that in a previous and ruder age, Neolithic man, in a less appreciative mood, had used this precious fossil as a whetstone!

The American specimens on which our present knowledge is based, are extraordinarily abundant in the upper Jurassic and Wealden beds of Maryland (*See* Figure 3.), Dakota and Wyoming.

Between fifty and sixty species have already been described and the individual specimens are extremely numerous, about a thousand trunks having been obtained from the Black Hills of South Dakota alone.

Dr. Wieland of Yale has carried out the investigation of this splendid material with brilliant success, though its extent is so vast, that the work can only be said to have begun.

The great conclusion to which his researches have led is, that the fructifications of these Mesozoic Cycadophytes were true bi-sexual flowers, comparable in a general way to those of such modern Flowering Plants as the *Magnolia* or the Buttercup, though differing in important details.

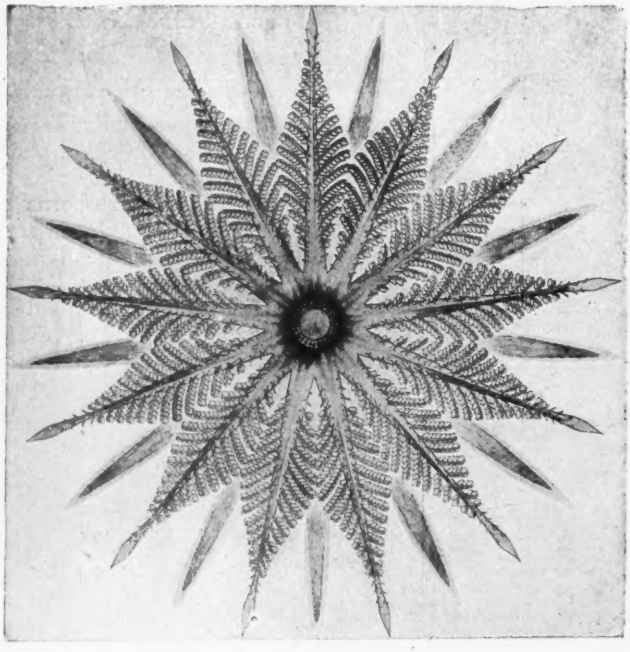

FIGURE 6. *Cycadeoidea ingens.*

Plan of the expanded bisexual flower, showing the central, ovuliferous receptacle, the whorl of thirteen compound stamens united at the base, and an envelope of hairy bracts. About half natural size. (After Wieland).

Reproduced, by kind permission, from "Studies in Fossil Botany."

In many cases, the flowers, which are often very perfectly preserved, had been fossilized while still young, with the ovules immature and the stamens folded within the bud, (*See* Figure 5.) The flowers were of large size; in a species illustrated, the total length in the bud condition was twelve centimetres (nearly five inches), of which about half was flower-stalk.

The envelope of the flower was formed by about a hundred overlapping bracts, forming a kind of perianth like the coloured petals of the *Magnolia*, and completely enclosing the true reproductive organs. Within the perianth came the whorl of stamens, complicated, branched structures fused into a tube at the base, like the stamens of a Mallow, and bearing on their leaflets numerous compound pollen-sacs in which the pollen-grains are preserved. (*See* Figures 5 and 6.)

The stamens were folded inwards in the bud, something like the young fronds of a Fern, with which, indeed, they shew close analogies. The centre of the Flower was occupied by a cone or receptacle, bearing numerous stalked ovules, embedded among sterile scales, which fused together to form the wall of the ovary.

There is no doubt but that the flowers of the European species, such as *Bennettites Gibsonianus*, had the same bi-sexual structure, but they have not yet been found at an early enough stage for the stamens to be preserved, except in the case of one Polish species, which Dr. Wieland has lately re-investigated.

The great interest of these discoveries lies in the fact that the Cycads of the Secondary Period turn out to have been in many cases, quite different from their distant allies now living, and as regards their flowers much more highly organized. They show a surprisingly near approach in the construction of their flowers to some of the Angiosperms, especially the Magnoliaceae, which have themselves been recognized in Cretaceous rocks. The numerous free perianth-leaves, the hypogynous stamens and especially the elongated, cone-like receptacle with the spirally arranged carpels, are the chief points in which Magnoliaceae show an analogy with the Mesozoic flowering Cycads.

Though we cannot suppose the Bennettitean Cycads to have been on the direct line of descent of the higher Flowering Plants, which succeeded them, yet the two groups have much in common.

The recent researches have led many botanists to the conclusion—unsuspected only a few years ago—that the origin of the Angiosperms which began to overspread the world in late Cretaceous times and have held the upper hand ever since, is to be sought among the great class of Cycad-like plants, which were dominant throughout the Wealden and the period before it.

The sudden rise of the Angiospermous flowering plants and the infinite variety in their flowers, was doubtless due to the contemporary insect life; for the higher insect families, which are chiefly concerned in the fertilization of flowers, arose at about the same time, as the Angiosperms themselves.

It is possible that this fertilisation by insects may

have begun amongst the Cycadophytes; the flowers of the fossil Bennettiteae must have been striking objects (*See* Figure 6.), and though we know nothing of their coloration, the bright tints, which we find to-day in the cones and ovules of some recent Cycads, suggest, that similar attractions may have been present in the more complex flowers of their ancient allies.

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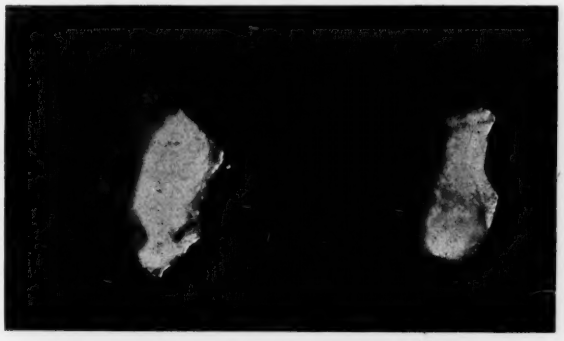
STONE IMPLEMENTS AND FLAKES FROM NORTHERN NIGERIA.

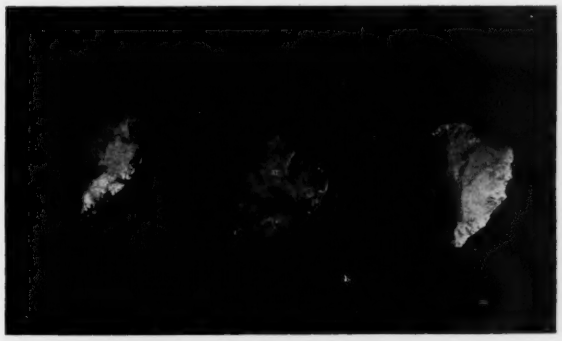
By A. SANTER KENNARD, F.G.S.

THROUGH the kindness of one of the Editors, I have been able to inspect a series of worked stone tools and flakes which were obtained in December 1908, near Tureta, in Sakoto Province, Northern Nigeria, by Mr. H. M. Frewen, and presented by him to Eton College Museum. The examples had been washed out of the side of a valley from under ten feet of soil. Since this is the first discovery of



QUARTZ IMPLEMENTS FROM NORTHERN NIGERIA.

stone tools in this part of Africa the importance is very great. There are about a hundred specimens shewing signs of artificial origin. They are all of quartz and have been made from rounded quartz pebbles, probably obtained from some river bed. It could scarcely be expected with such intractable material that any well-made implements would be fabricated, yet there is one beautiful scraper which denotes great skill and dexterity in chipping. This has been made from a trilateral flake. It is twenty-five millimetres in length with an exclusive breadth of eighteen millimetres and it is six millimetres thick at the scraper end. There are two well made notches at the side as though for attachment in a handle. Eight other flakes shew signs of either secondary work, or what is more probable "use." The remainder are flakes, some of which, from their shape, may well have been arrowheads, but since there is no secondary chipping it is impossible to speak definitely. All the flakes are small, no doubt owing to the size of the raw material. There is considerable resemblance in this respect between these African flakes, made from quartz pebbles, and the neolithic flakes to be found on the Suffolk coast, made from beach pebbles. All of them are extremely sharp and have suffered no abrasion in a stream bed, and we are therefore justified in assuming that the spot where they were found was an old working site. As to their age one has only the general facies to go upon and from these one must conclude that they are "Neolithic." That true Palaeolithic implements do occur in Africa there can be no doubt. Besides the well-known tools from the river grounds of Egypt and from Algiers, a very large number have been found in South Africa, which from their stratigraphical position as well as their shape are certainly of this age. These have been well figured by my friend, Mr. J. P. Johnson, in his excellent work "The Stone Implements of South Africa." But these have nothing in common with the Nigerian tools even after making due allowance for differences in material. There is, however, great resemblance between these Nigerian tools and those from South Africa which have been assigned to the Bushmen. Implements of quartz are extremely rare since it is eminently unsuitable for flaking and whenever used



SMALLER QUARTZ IMPLEMENTS.

it has only been on account of the absence of better raw material. Neolithic flakes of white quartz have, however, been found in Banffshire and Mr. Clement Reid, F.R.S., has described some rude tools of vein-quartz found at Prah Sands, Cornwall, probably of Pleistocene age.* This discovery greatly enlarges the area in Africa from which stone implements have been obtained.

(**See Quart. Jour. Geol. Soc.*, vol. LX. (1904) *pp.* 106-112.)

XUM

THE ROYAL MICROSCOPICAL SOCIETY AND ITS MISSION.

By A FELLOW.

It is often said that our learned Societies do not move with the times, or, at any rate, not so quickly as many of their Fellows would like. The present article forms the first of a series which it is hoped will throw some light on the matter.

TIMES have changed since the Royal Microscopical Society was first instituted, and the conditions of its usefulness in years gone by have in many respects ceased to exist. It becomes necessary, therefore, if the Society is to have a justification for vital continuation, that its methods and its scope should be changed to meet new requirements.

Reference to the Journal of the Royal Microscopical Society for the past few years will disclose a plethora of communications on the subjects of Foraminifera, Diatoms and Pond Life, but comparatively few on those more serious and vitally important subjects in which professional workers are principally engaged and which owe the knowledge of their existence entirely to the microscope.

In former years, the Royal Microscopical Society was among the first to receive communications of any original investigation connected with Microscopy. This is no longer the case, for the reason that nearly every branch of science has its own representative Society, and the results of observations are communicated to the Society that is interested. This seems quite legitimate and proper, and undoubtedly a higher degree of appreciation and more critical interest is taken by specialists under such conditions than if the investigations were communicated to a body that is so many-sided as the Royal Microscopical Society.

There is another factor in all this, and that is—the low ebb of appreciation of the microscope and microscopical work amongst amateurs. Before the advent of photography and the bicycle, and more recently the motor-car, the microscope had a larger number of votaries amongst educated amateurs than at the present day. The non-existence of many well-remembered Societies that flourished twenty years ago is a confirmation of this fact. This is greatly to be deplored, for the present high state of efficiency which the microscope has attained has been almost entirely due to the initiative, encouragement, and work of amateurs. There is no doubt but that the Royal Microscopical Society's mission could be extended to foster once again the interest of amateurs.

Further, the Journal of the Society is not so attractive nor so useful to its readers as it should be. Against the comparatively small number of readers who appreciate the extracts from other journals, of which about half the average bi-monthly issue consists, there is to be placed a large majority who set but small value on them. The expense of production and printing is in itself a heavy load on the back of the Society, and the Journal, under altered conditions, could be made increasingly serviceable to a very much larger number.

If the foregoing statement truly describes the present state of affairs—and to the best of my belief it does so—in what manner may the Society render the useful, indispensable and progressive service to Microscopy that it can and ought to do?

The Society should rightly be the judicial authority on all matters affecting the microscope, objectives and accessory apparatus. In it by common consent should be vested the authority for the standardisation, not only of the parts that are made of metal, but of the lenses also.

For several years a movement has been growing to establish standard tests for objectives. The Royal Microscopical Society should be the authority not only to set up such standards but actually to make the tests when required to do so, for even to this day it is well known among critics that objectives are frequently not of the power, aperture or quality that they purport to be, and the same remark applies to condensers and other optical appliances.

The Society has in the past established standard sizes for eye-pieces, objectives and sub-stages. In eye-pieces, the sizes were too numerous, and two only remain in general use. In objectives, the same chaotic condition prevails as before the fresh standardisation, and it is quite a common thing for objectives of different makes not to interchange.

Notwithstanding the Society's standard size, substage fittings are still made in other diameters. It is doubtful whether any improvement in this direction has been made in recent years, yet if the Society were the acknowledged authority that it should be, it could do a great deal more than has been done in causing its standards to be respected.

Instruments of new design are frequently submitted for the commendation and criticism of the Fellows at the meetings of the Society. A condition could be made in respect of such instruments that they would be examined for standard sizes, and a report in this respect would be made at the time of exhibition.

There are yet other directions of usefulness. It is well known and constantly deplored that amongst professional workers with the microscope, and in laboratories, the knowledge of microscopical optics and manipulation is of the most elementary description. Work would be vastly improved and interpretation of results more accurately made if a fuller technical knowledge existed. Some time ago the Manchester Microscopical Society arranged that certain of its members should give lectures on request with regard to matters of general interest in microscopy. It should be possible for the Royal Microscopical Society to arrange for and appoint lecturers on microscopical manipulation and technique, for the purpose of visiting laboratories and

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centres where the microscope is in constant use. A large field of usefulness is open here. I am sanguine enough to hope that in years to come, lecturers in Microscopy will be found in all Universities and Colleges.

Allusion has already been made to the Journal of the Royal Microscopical Society, and the suggestion is made that it could be rendered more generally useful by the omission of much of the reference matter, and the addition of a greater amount of general microscopical notes contributed in many cases, as they might well be, by Fellows of the Society.

Microscopy is very inadequately represented in literature, and interest with regard to the subject could be fostered by making the Society's Journal deal with matters of a more general kind. With a reduced size, different contents and lessened price, there is no doubt but that a large number of microscopists unconnected with the Society would become subscribers. The Society's work would be made more widely known, independent workers would be materially assisted and the Society itself would benefit indirectly to a very considerable extent.

Few even of the Fellows of the Society are fully aware of the resources which it possesses in its Library, its cabinets of slides and collection of old microscopes. A useful step has been taken recently in issuing a catalogue of the Library, but a casual visitor to the rooms could form no adequate idea of the extent and variety of the collection of instruments. Some better means are desirable for enabling them to be better seen and more widely known.

The Royal Microscopical Society possesses unique advantages from its high position. It already influences and shapes matters microscopical in a quiet and unobtrusive way. It numbers among its executive and members, men eminent in science and keen in their interest in the microscope. It is counted an honour to be a Fellow of the Society, and those who have attended the meetings have found a readiness on the part of experts to give advice and assistance which has been both helpful and encouraging, and if its many advantages were more widely known, its power would be increased by a larger roll of Fellows.

The Society has had an irreproachable and glorious past. It is actively working to-day; but it has a larger sphere of usefulness than is being attempted, and the object of these notes is to indicate some lines on which it could work so that it might maintain and be confirmed in its position as the authoritative body of the World in all those matters included under the heading microscopical.

THE BUREAU OF BRITISH MARINE BIOLOGY.

A NEW MARINE LABORATORY.

IN connection with the Bureau of British Marine Biology which was instituted some time ago by Mr. Stephan Pace, there is now a proposal to establish a new marine laboratory for the special study of those questions with regard to our British marine fauna and flora which are to a great extent overlooked by the morphologist and which the enthusiastic amateur is unable to satisfactorily elucidate by his own unaided efforts.

The intention is to conduct an extensive and continuous biological survey of some one particular and small area to be chosen. It is surprising how prevalent is the idea that an elaborate and expensive equipment is necessary before any good work can be done. Of course Mr. Pace will need some financial support, yet in the well-considered scheme which he has drawn up he emphasizes the fact that the cost need be very small indeed.

The proposed laboratory will not only carry on definite faunistic research by its own staff, but it will assist the work of other biologists (both professional and amateur) by providing material, by granting working facilities at the station, and by giving information through the Bureau. All such services will be rendered quite gratuitously, and it is interesting to learn that no attempt will be made to carry on any trade in museum specimens or laboratory material.

The record system provides a list, with revised nomenclature, of the members of the British marine fauna and flora. It includes references to the best available description of each species or form, together with diagnoses and notes on its characters, distribution and habits. And a synonymic index will be added of the names of the genera and species which have been at any time recorded as British.

The records, though continually increasing, are of course very incomplete; but as the manuscript is all in the form of card or loose-leaf catalogues, the information contained therein is at all times readily available for reference. This, and indeed the whole organization of the Bureau, will be at the disposal, without any charge whatever, of every biologist who is interested in the British marine fauna and flora; and it is hoped that through its intervention the numerous scattered workers, both professional and amateur, may be brought into closer touch with one another's work.

Further information may be obtained on application to the Director of the Bureau, at 6, Provost Road, Haverstock Hill, London, N.W.

XUM

COUNTING THE STARS.

By J. E. GORE, F.R.A.S.

With a full page illustration from a photograph by Dr. Max Wolf.

PLINY says that Hipparchus "ventured to count the stars, a work arduous even for the Deity." This remark referred to a catalogue of stars formed by Hipparchus about the year 129 B.C., the first complete, or nearly complete, catalogue of stars visible to the naked eye that had ever been attempted. Ptolemy tells us that it was the sudden appearance of a bright new or "temporary star" which led Hipparchus to the formation of his catalogue, and there seems to be no good reason to doubt the truth of this story, as the appearance of a bright new star is recorded in the Chinese Annals as having occurred in the year 134 B.C., or five years before the date of Hipparchus' catalogue. This catalogue contained one thousand and twenty-eight stars visible to the naked eye in the latitude of Rhodes; but as we now know that many more than this number can be seen with unaided vision, Hipparchus must have only recorded the brightest, and omitted all those which were not immediately connected with the old constellation figures of men and animals. These figures are of great antiquity and were formed long before his day.

Hipparchus was born about 160 B.C., so that he was about twenty-six years of age when his attention was attracted to the heavens by the appearance of the bright new star referred to above. He was a native of Nicaea, in Bithynia, and lived at Rhodes, where he probably made most of his observations, and not at Alexandria as is sometimes stated. He discovered the precession of the equinoxes, and measured the length of the year, the obliquity of the ecliptic, the moon's parallax, and other motions connected with the earth and moon. He was a very careful observer, and has justly been styled "The Father of Astronomy."

The catalogue of Hipparchus was revised by Ptolemy in his famous work the *Almagest*. Ptolemy reduced the positions of the stars as given by Hipparchus to the year 137 A.D., but used an incorrect value of the constant of precession which only corresponded to about the year 63 A.D., and he probably adopted the star magnitudes, or figures representing their relative brightness, as given by Hipparchus, without revision. Indeed it seems doubtful whether Ptolemy made any observations of the stars himself; but, as the original of Hipparchus' list is lost, we can only depend on Ptolemy's catalogue for the star magnitudes recorded in those ancient times.

Very little is known of Ptolemy's life. His real name was Claudius Ptolemaeus. It seems certain, however, that he observed at Alexandria in the years 127 to 151 A.D. during the reign of the Roman Emperors Hadrian and Antoninus Pius, and as he survived the latter he must have been alive in A.D. 161. According to an Arabic tradition he lived to the age of seventy-eight. The correct title of his work known as the *Almagest* was Μεγάλη Σύνταξις της 'Αστρονομίας. The name *Almagest* is a compound of the Arabic article *al*, the, and the Greek μεγίστη greatest, meaning his greatest work. It was translated from Greek into Arabic about the year 827 A.D. by Ishak Ibn Houain by order of the Caliph Al-Mamun, who reigned at Baghdad at that time. The Emperor Frederick II had it translated into Latin from an Arabic edition about the year 1230, and about the year 1350 Girardus of Cremona made a translation of it at Toledo. A translation by Liechtenstein was *printed* at Venice in 1515. From internal evidence this translation seems to have been made from an Arabic manuscript. The Greek text of the *Almagest* was printed at Basle in 1538, accompanied by a commentary on it by Theon of Alexandria (fourth century), father of the famous Hypatia. This edition was edited by Simon Grymnaeus. A Latin translation from the Greek text was also made by Trapezuntius (George of Trebizond), and published by Gauricus, at Venice, in 1528. This is said to have been made from a copy of a Greek manuscript which the Abbé Laurentius Bartolinus had made from one in the Vatican Library. A Greek edition, corrected by Halley, was also printed at Oxford in 1712. Another Greek edition, with a French translation, was published by Halma in 1816. This was chiefly derived from a ninth or tenth century Greek manuscript preserved in Paris.

Al-Sufi's "Description of the Fixed Stars," visible in Northern latitudes, was written in the tenth century and contains one thousand and twenty-two stars. He seems to have adopted the *positions* of the stars as found by Ptolemy (or Hipparchus), merely correcting them for the effects of precession; but he made a very careful revision of the star magnitudes given by Ptolemy, from his own observations, and this renders his work the most valuable, from this point of view, of all the ancient catalogues. Pliny remarked with reference to the catalogue of Hipparchus, *Coelum posteris in hereditatem relictum*, and the same may be said of Al-Sufi's work. An account of this work is given in my book "Astronomical Curiosities."

To show the usual great accuracy of Al-Sufi's estimates of star magnitudes I give the following

examples of his estimates compared with moderate estimates and photometric measures :—

Star.	Mag. — Al-Sufi.	Mag. — Argel-andu.	Mag. — Heis.	Photometric Measures. Harvard.	Potsdam.
α Tauri (Aldebaran)..	1	1	1	1·06	1·18
α Persei	2	2	2	1·90	2·17
η Boötis	3	3	3	2·80	3·08
η Pegasi	3	3	3	3·06	3·24
ε Ophiuchi	3-4	3-4	3-4	3·37	—
ζ Tauri	4-3	4-3	4-3	3·77	4·0
ι Geminorum ...	4	4	4	4·03	4·03
κ Cassiopeiae ...	4-5	4-5	4-5	4·24	—
λ Draconis	5	5	5	4·98	—
η Arietis	5-6	5-6	5-6	5·37	5·44
ω Tauri	6	6-5	6	5·82	5·76

About the year 1437, Ulugh Beigh, son of Shah Rokh, and grandson of the Mogul Emperor Tamerlane, published a catalogue of stars in which he corrected Ptolemy's position, but he seems to have accepted Al-Sufi's star magnitudes without any attempt at revision*. Ulugh Beigh's catalogue contains one thousand and eighteen stars. The name Ulugh Beigh means the Great Lord. His real name was Mohammed Tarragaï Ibn Shah-rokh Ibn Timur, and he was born in 1393. He was assassinated in 1449, by order of his own son, who had defeated him in a battle near Samarcand. The name Tamarlane is a corruption of Timur-len (Timur the Lame).

All the catalogues mentioned above were made before the invention of the telescope, and without optical assistance of any kind. The old observers probably possessed keen natural eyesight unimpaired by civilisation. This is shown by Al-Sufi's reference to the large number of faint stars below the sixth magnitude which he speaks of as having seen, but did not fix their exact position owing to their great multitude.

In the year 1602, the famous Danish astronomer, Tycho Brahé, published a catalogue which contained seven hundred and seventy-seven of the principal stars visible in Denmark. This was afterwards enlarged by Kepler to one thousand and five stars from Tycho Brahé's observations.

In recent years several maps and catalogues of stars visible to the naked eye have been published. Of these the first was made by the famous German astronomer, Argelander, and was published at Berlin in 1843. It is called the *Uranometria Nova*, and included stars from the North Pole to 26° South of the Celestial Equator.

Heis' *Atlas Coelestis Novus* was published at Coeln in 1872. It contains four thousand nine hundred and forty-three stars visible to the naked eye from the North Pole to 20° South Declination. This is a very accurate work, and includes stars to sixth to seventh magnitude, or about one-third of a magnitude fainter than the sixth magnitude, which was the limit of the ancient catalogues.

Behrmann's Atlas of the southern stars from 20° South Declination to the South Pole, with the title *Atlas des Gestirnten Himmels* was published at Leipzig in 1874. It contains two thousand three hundred and six naked eye stars. Adding the results found by Heis and Behrmann, we have a total of seven thousand two hundred and forty-nine stars visible to the naked eye in both hemispheres, or an average of half of this, three thousand six hundred and twenty-four stars, visible from any one place at one time.

Houzeau's Atlas of naked eye stars was formed from observations made at Jamaica and Panama in 1875. It contains nearly six thousand stars, and shows all those visible to the author without optical aid in both hemispheres of the sky. It was published at Brussels in 1878.

Gould's great work, the *Uranometria Argentina*, shows the stars of the southern hemisphere down to the seventh magnitude. This is well below the limit of ordinary eyesight, but a good opera glass will show them all. The catalogue includes over eight thousand stars to six and a half magnitude south of the Celestial Equator. It was published in 1879.

I find that the total number of stars seen by Heis with the naked eye gives about 5·6 square degrees to each star. This is a considerable space, about twenty-seven times the apparent area of the full moon. Behrmann's maps give about six square degrees to each star. Were there even one star to the area of the full moon, we should have about one hundred and eighty thousand stars in both hemispheres visible without telescopic aid, compared with about seven thousand actually visible. This shows how sparsely scattered the naked eye stars really are. Far from being innumerable, as some people imagine, they are in reality comparatively few in number. This conclusion is beyond all dispute, and, as lawyers say, is "not arguable." A few experiments on a clear moonless night will show the truth of the above statement. Take the four stars in the "Plough" (Ursa Major), which form a quadrilateral, or bowl of the "Dipper," as the Americans call it. Within this area, which is many times larger than the full moon, Heis, who had remarkably keen vision, saw only eight stars, and I think there are not many people who will see more, if so many. Again, take the well-known "square in Pegasus"—a much larger area. In this space Heis shows thirty-six stars, and some of these are below the sixth magnitude, which is supposed to be about the limit of ordinary eyesight. This gives about six square degrees to each star, or about seven thousand naked eye stars in the whole sky, which confirms the result found above from Heis' and Behrmann's maps and catalogues.

To show the distribution of the naked eye stars in the sky I have taken a zone between 10° North of the Equator, and 10° South of it, and made a careful

* See Mr. E. B. Knobel's papers on this subject in the *Monthly Notices, R.A.S.* for 1879 and 1884.

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count of the stars shewn by Heis in his atlas. The result is as follows :—

STARS IN HEIS' ATLAS.
BETWEEN 10° N. DECL. AND 10° S. DECL.

Hour.	From Equator to 10° N.	From Equator to 10° S.	Totals.	Remarks.
h				
0— 1	15	16	31	Constellations, Pisces and Cetus.
1— 2	17	17	34	Do. do. do.
2— 3	25	29	54	Cetus and Eridanus.
3— 4	21	25	46	Taurus and Eridanus.
4— 5	31	28	59	Taurus, Orion, and Eridanus.
5— 6	39	38	77	Orion, Faint Milky Way.
6— 7	32	33	65	Monoceros, Milky Way. [Way.
7— 8	35	22	57	Monoceros and Canis Minor. Milky
8— 9	25	20	45	Monoceros and Hydra.
9—10	21	34	55	Hydra and Sextans.
10—11	29	24	53	Sextans and Leo.
11—12	28	21	49	Leo, Virgo and Crater.
12—13	19	20	39	Virgo.
13—14	25	22	47	Do.
14—15	27	26	53	Virgo and Libra.
15—16	19	16	35	Libra and Serpens.
16—17	21	16	37	Hercules. [M. Way.
17—18	27	16	43	Hercules, Ophiuchus and Serpens.
18—19	20	18	38	Ophiuchus and Aquila. Milky Way.
19—20	44	26	70	Aquila. Milky Way.
20—21	22	19	41	Aquila and Aquarius.
21—22	24	26	50	Equuleus, Pegasus and Aquarius.
22—23	22	30	52	Pegasus and Aquarius.
23—24	30	20	50	Pisces and Aquarius.
Totals ...	618	562	1180	

The area of this zone is seven thousand one hundred and sixty-two square degrees. On this area we have —as shown in the above table one thousand one hundred and eighty stars visible to the naked eye, which again gives on an average about six square degrees to each star.

If we use an opera glass or binocular field glass, the number of stars seen is of course largely increased. Thus, in the well-known group, the Pleiades, where only six or seven stars are visible to ordinary eyesight a binocular field glass will show thirty or forty stars, or more. With a moderately sized telescope the number becomes still greater. In Harding's Atlas, published in 1822, which shows stars to about the eighth magnitude, or about the limit of an ordinary opera glass, the number shown is about forty thousand from the North Pole to 30° South Declination.

In the year 1871, the famous German Astronomer Argelander, published a catalogue with charts of stars visible with a telescope of less than three inches aperture. This is known as the *Durchmusterung*, and contains over three hundred and twenty-four thousand stars down to about $9\frac{1}{2}$ magnitude from the North pole to 2° South of the Equator. This catalogue was extended by Schönfeld to 23° South Declination, and by Thome at Cordoba from 22° to 42° South of the Equator. With larger telescopes more stars are of course visible, and by the aid of photography the number has been increased in recent years to millions.

The International scheme for charting the stars by photography has been at work for several years past, and is now approaching completion. It has been recently estimated that these charts when completed will probably contain nearly ten millions of stars, down to the fourteenth magnitude in the whole sky. Prof. Pickering estimates that the total number of stars visible in the great Lick telescope of thirty-six inches aperture would be about fifty millions. The faintest stars visible in this giant instrument are about the sixteenth magnitude ; but on photographic plates taken with long exposures much fainter stars than this are visible and the above number will be largely increased. By means of a large number of counts made by the present writer on photographs taken by the late Dr. Isaac Roberts, he finds a total of about sixty-four millions for the whole sky in both hemispheres. But as more stars would probably be visible on the original glass plates, we may perhaps assume that the total number will be about one hundred millions. This is, of course, a large number, but must be considered as comparatively small if we consider the sky room available and the excessively small area covered by each star disc.

Taking the total number of the *visible* stars at one hundred millions—the number now usually adopted by astronomers—let us see what area of sky would, on an average, contain a single star. The area of the whole star sphere is forty-one thousand two hundred and fifty-three square degrees. This gives about two thousand four hundred and twenty-four stars to each square degree. Now there are three thousand six hundred square seconds in each square minute, so that a square degree contains the square of this, or twelve million nine hundred and sixty thousand square seconds. Dividing this number by two thousand four hundred and twenty-four, we have five thousand three hundred and forty-six square seconds to each star. That is, on a square, the side of which is about seventy-three seconds of arc, there will be, on an average, one star. In a good telescope, seventy-three seconds of arc seems a considerable space when viewed with a high power, so that, with the exception of the globular clusters, there is no real crowding of stars in the sky. Even in a rich globular cluster like Omega Centauri I find that there are, on the average, about five-hundred and eighteen square seconds of arc to each of the component stars, or a square of about twenty-three seconds of arc in the side.

As the disc of a star covers a very small fraction of a square second, we see that it is quite a mistake to suppose that the stars are really crowded in the sky. Although they seem to be thickly scattered on stellar photographs, the above calculation shows that there would be ample room for at least one hundred times the number of stars actually visible in the largest telescope, or on photographic plates taken with long exposures.

It seems to be a popular idea among those who have not studied the subject that the number of stars in the heavens is practically infinite. But the above calculations will show clearly that this idea is quite fallacious, and that far from being "infinite," the number of stars which are visible in even the largest telescopes is *comparatively speaking* small.

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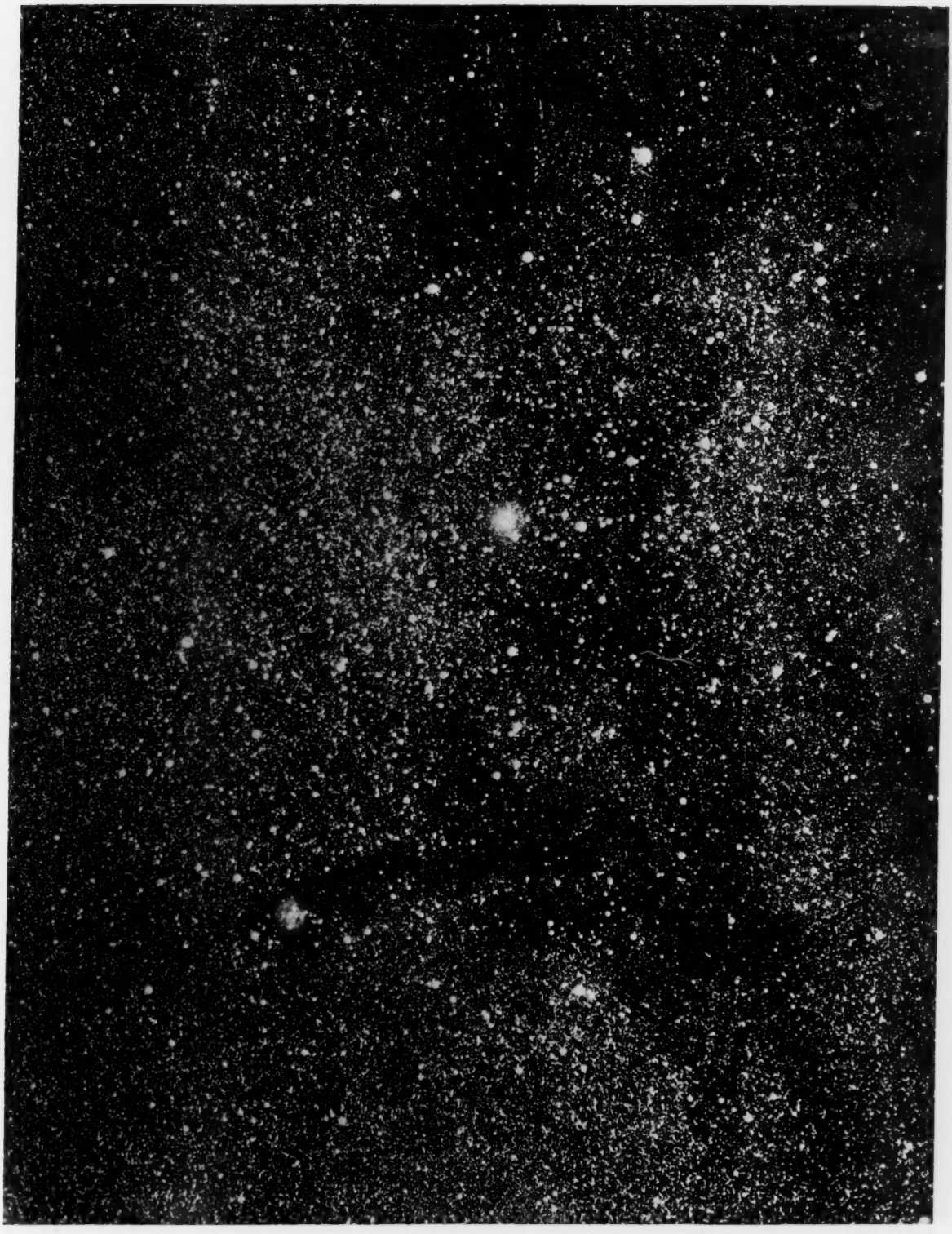

From a photograph by *Dr. Max Wolf, Heidelberg.*

The Milky Way and Nebula near π_2 Cygni.

Exposure four hours, with a sixteen inch telescope.

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LIVERWORTS WITH LEAF-PITCHERS.

By PROFESSOR F. CAVERS. D.Sc., F.L.S.

Professor of Biology at Hartley University College, Southampton.

PROBABLY no group of plants has been so much neglected alike by the botanist and the student of Nature as that of the liverworts or Hepaticae. The allied group of the Mosses has attracted large numbers of ardent devotees, but comparatively few naturalists and workers with the microscope appear to have paid much attention to the humbler but equally interesting liverworts.

These two groups together form the central sub-kingdom of the plant world—the Bryophyta—which stands between the Thallophyta (Algae, Fungi, Lichens) on one hand and the Vascular Plants on the other. As compared with the Mosses, the liverworts are fewer in number of species, less abundant, more delicate in texture, and more decidedly moisture-loving plants. Moreover, their spore capsules, or fruits, are less conspicuous and in most cases very short-lived, appearing usually in Spring or early Summer and disappearing directly after they have shed the spores—a process which in many cases takes only a few days. For all these reasons, the leafy liverworts are often overlooked even by the zealous hunter for Mosses.

The leafy liverworts have been mentioned first because the great majority of these plants are differentiated into stem and leaves. The name liverwort itself is somewhat misleading, for it was given to the relatively small number of species in which the plant-body consists of a flat lobed plate which creeps over moist soil. The lobes of the plate, or "thallus," suggested a likeness to the lobes of the liver, and by a natural process of reasoning the early herbalists inferred that more or less liver-like plants must necessarily afford medicine for the cure of the troubles to which that important organ is subject! Hence the common *Marchantia*, found on the soil in flower-pots and greenhouses, besides growing wild beside streams, figured in Pharmacopoeias as an officinal plant until a comparatively recent date.

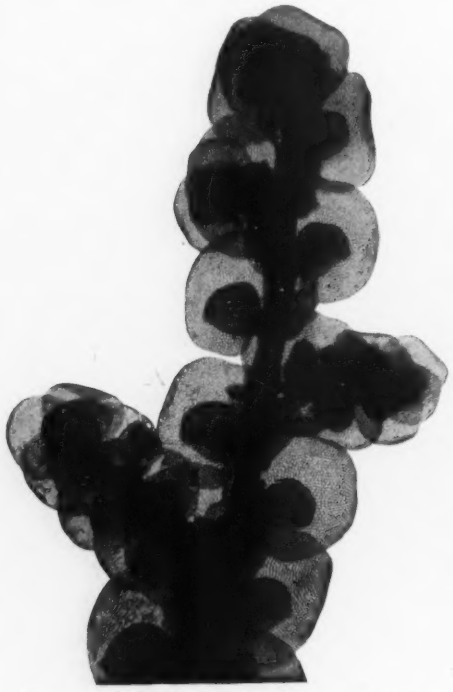

FIGURE 1. *Frullania dilatata*, magnified.

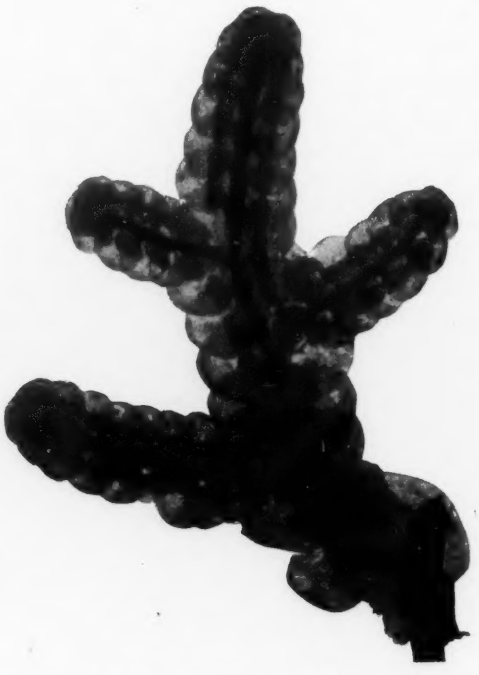

FIGURE 2. *Frullania tamarisci*, magnified.

We propose dealing here with a few of the leafy liverworts which bear curious pitchers on their leaves, and chiefly with two very common British species. If we examine the trunk of a smooth-barked tree—especially the beech—growing in a moist wood or beside a stream, we generally notice, in addition to numerous crust-lichens and some mosses, a small, usually purplish-brown, moss-like plant closely pressed

to the bark and branching in a very regular feather-like fashion, with roundish over-lapping leaves arranged in two rows along the slender stem. On pulling the plant from the bark, we see that it is fastened down here and there by tufts of fine hairs, and on holding it up to the light and examining its underside with a lens, a third (middle) row of smaller leaves becomes visible, while on each of the roundish side-leaves, close to the stem, there is a minute oval body—the pitcher. The plant is a species of *Frullania*, and may be either *F. dilatata* or *F. tamarisci*; the latter species—both are about equally common — forms larger patches, and is further distinguished by being glossy and darker in colour, and it grows on rocks as well as on tree trunks, which *F. dilatata* very seldom does. With a low power of the microscope the two species are seen to differ considerably (*See* Figures 1, 2, and 3.); in *F. dilatata* the leaves are rather loosely arranged and are transparent, the pitchers broad and helmet-shaped, while in *F. tamarisci* the leaves are more crowded and darker, and the pitchers relatively smaller and deeper. In both species the leaves consist of a single layer of cells, and there is no vein or midrib, such as is found in many of the Mosses—in *F. tamarisci*, however, there is often a row of dark-coloured cells along the middle of the leaf.

Of what use to the *Frullania* plant are these curious cups or pitchers? In the natural position of the plant, the pitchers are closely pressed against the bark of the tree, and they serve to hold part of the rain-water which trickles down the trunk during a shower, and which would be lost otherwise. In this way the plant is enabled to hoard up its somewhat precarious water supply in a much more effective manner than would be possible if it relied solely on the retention of water by capillarity in the space between its flat leaves and the bark on which it grows. Close inspection shows that each of the side leaves is divided nearly to the base into two lobes, the upper lobe being large, flat or somewhat curved, and forming the main portion of the leaf, while the lower lobe is the pitcher, which is open behind. Between the pitcher and the stem itself, there is a slender outgrowth (Figure 3, D.), and this doubtless co-operates with the side-leaves and the under-leaves in the formation of capillary spaces, which retain water, but the pitchers themselves are the reservoirs for storing water during dry weather. The under-leaves, arranged in a row along the lower side of the stem, are smaller than the side-leaves, and each is notched at the front. The plant, though small and simple in structure, offers an interesting example of division of physiological labour: the side-leaves are exposed to the light and make food, the small hollow lobes (pitchers) store up water, and the under-leaves help to form capillary water-holding spaces and also bear the tufts of rooting hairs.

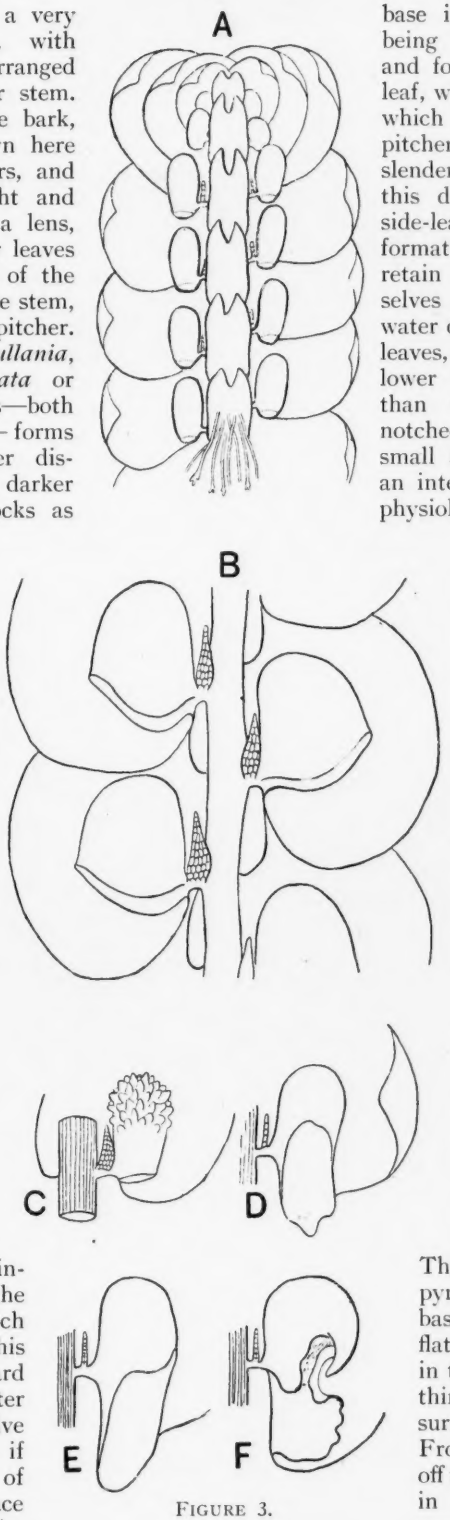

FIGURE 3.

Various species of Frullania, seen from the lower surface, magnified.

A, *F. tamarisci*; **B**, *F. dilatata* (the underleaves removed); **C**, *F. repandistipula*; **D**, *F. ringens*; **E**, *F. arecae*; **F**, *F. ecklonii*.

In order to get a clear idea of the biology of *Frullania*, it is necessary (1) to study the development of the different organs, (2) to make experiments with the plant and ascertain whether under altered conditions the mode of development is affected. The growth of the plant takes place by means of a single cell (apical cell) at the growing tip of each branch, and in order to follow the stages of development here it is convenient to imbed the plant in paraffin and cut serial microtome sections—a good deal can be learnt from hand-sections, but of course all the loose parts fall away when that simple method is employed. The apical cell is shaped like a pyramid with a slightly curved base projecting forwards and three flat sides, two of the latter meeting in the middle line above, while the third is parallel with the lower surface of the stem (*See* Figure 4.). From the three flat sides are cut off three sets of cells, or segments, in spiral order, the apical cell growing in size after each segment is cut from it. Without describing the details which are shown in Figures 4 and 5, it is enough to

note that each segment contributes to forming the tissue of the cylindrical stem, besides giving rise to a leaf, and that the rudiment of each side-leaf divides into an upper and a lower half, the two halves at first growing out independently and with almost equal vigour for some time. Afterwards, the upper half of the young leaf outstrips the lower in its rate of growth and bends over the growing point; all the leaf-lobes when young bear gum-secreting hairs which keep the apex moist. The small lobe is at first a rounded or oval plate, but soon its growth is restricted to the middle, so that it gradually becomes hollow and eventually forms a pitcher.

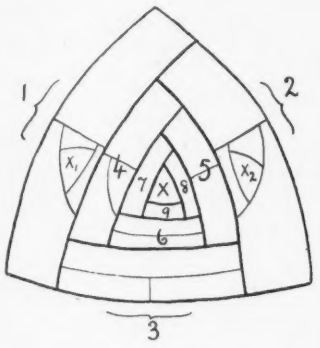

FIGURE 4.

Diagram of the Apical Growing-point, seen from the front.

X, is the apical cell of the main axis; the last nine segments cut from it are numbered; **X1**, **X2**, are the apical cells of branches.

So much for the normal growth and development. Now, if we could cause the plant to grow in such surroundings that the storage of water would no longer be necessary, would the pitchers be produced as usual, or not? Let us transfer some healthy *Frullania* plants to pieces of brick or tile, sloping into a dish of water covered with a bell-glass, so that the plants are grown in air saturated with moisture. Some of the older parts will die off, but the new branches formed under these novel conditions are found to bear, instead of pitchers, flat rounded or triangular lobes (*See* Figure 5, B.). That is to say, the development of the pitchers is arrested, and the normal hollowing-out process does not take place. The result of this simple experiment confirms our guess that the function of the pitchers is that of water storage. As a matter of fact, on examining plants placed under the microscope on a dry slide, we can ascertain that the pitcher contains water, with an air-bubble which varies in size according to the moist or dry state of the plant as a whole—in dry weather the water is reduced to a mere film lining the wall of the pitcher.

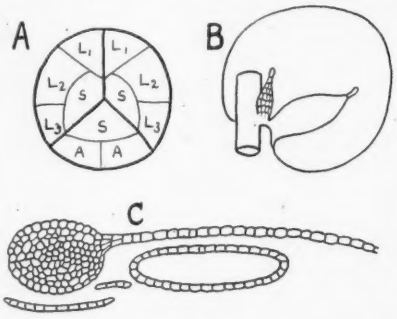

FIGURE 5.

A, Diagram to show the early divisions in the segments (see Figure 7); **S**, **S**, **S**, are the cells which contribute to the stem; **L1**, **L2**, **L3**, form respectively the lobe, lobule, and stylus of a sideleaf; **A**, **A**, the two lobes of an underleaf. **B**, Leaf of *F. dilatata* grown in moist surroundings; the lobule has remained flat instead of forming a pitcher. **C**, Cross-section of *F. dilatata*, showing stem, pitcher, stylus, and underleaf.

But these pitchers do not benefit merely the *Frullania* plant itself, for we commonly find in them all sorts of small organisms which have entered the pitchers for the sake of the shelter and moisture and have made their homes, either temporary or permanent, in these structures. Among these organisms there are algae, rotifers ("wheel animalcules"), and insect larvae. So frequently are rotifers found in the pitchers that it has been suggested that these animals remain permanently in their new lodgings, becoming rounded and passing into a resting stage in dry weather, and that when they die the plant absorbs the products of their decay. In fact, the pitchers of *Frullania* have been compared to those of *Nepenthes* and other insectivorous plants which capture their prey by entrapping them into pitchers and secreting ferments by means of which the hapless insects and other captives are digested after finding a watery grave. This, however, cannot easily be proved in the case of *Frullania*; at any rate, there is no evidence of any special digestive action, though possibly the plant may benefit slightly by absorbing the decayed remains of the organisms that happen to die inside the pitchers.

In a few other liverworts we find pitchers more or less similar to those of *Frullania*. In many of the tropical species of this genus itself, the pitchers have curious shapes; the mouth is often drawn out like a scoop, folded, and toothed at the edge (*See* Figure 3, C to E.). In another British genus (*Radula*), also found on tree trunks but not so common as *Frullania*, there are rudimentary pitchers, or rather pockets, formed simply by the small lower leaf-lobe being folded upon the large upper lobe. In some foreign liverworts allied to *Frullania*, the pitchers are much more elaborate, and there may even be a trapdoor mechanism, like that of the Bladderwort (*Utricularia*), which is hinged and readily opens inwards, but springs back to the closed condition once the enterprising animalcule has entered! In another foreign genus, belonging to a different family of leafy liverworts, the pitchers are developed profusely all over the underside of the plant, several from each leaf (*See* Figure 6.); the genus referred to—*Polyotus*—excels even *Frullania* in elegance and beauty.

But to return to our special type. The stem of *Frullania*, like the leaves, has no mid-rib or vein for the conduction of water, though special conducting bundles are found in a few of the flat strap-like (*thalloid*) liverworts. The cells of the leaves have at first thin colourless cell-walls, but later the walls become strongly thickened—chiefly at the corners, as may be seen in Figure 1—and deeply stained reddish or purplish; thin places are left, however, through which water and salts can pass readily. The degree of wall thickening and colouration depends largely on the habitat of the plant—the thickest and most deeply coloured walls

occurring, as we should expect, in plants growing in the most exposed situations. Experiments show that the thickness of the cell-walls is influenced chiefly by the amount of moisture in the surroundings, while their colouration depends solely on the intensity of the light. Since there is no impervious cuticle, water can be absorbed by the whole surface of the plant, and can be stored, during drought, not only in the pitchers but also in the cavities and even the walls of the leaf-cells; plants kept constantly moist dispense not only with pitchers but also with thickened cell-walls. The leaf-cells contain green chlorophyll grains, though these are somewhat masked by the coloured walls, and experiments show that in deeply tinged plants of *Frullania* the gaseous exchanges concerned in the processes of food-making ("assimilation") and of respiration are less active than in green plants of the same species — the most active growth and other vital processes go on in the green young regions at the tips of the branches.

Frullania has two regular methods of reproduction, in addition to the power possessed by every living part of the plant to produce new plants when detached and kept moist, or grown in culture solutions. In the regular asexual method, small disc-like bodies *(gemmae)* are produced on the leaves, becoming detached eventually and producing new plants.

FIGURE 6. *Polyotus magellanicus*, an exotic liverwort. Part of a plant showing the lower surface of four branches, with numerous water-sacs.

In order to study the more complicated sexual method of reproduction, the plants must be examined throughout the year—continuous or frequently repeated observations must be made on all the liverworts in order to trace out the complete life history. The sexual organs are formed in Autumn, or in late Summer, and the fruits, or spore-capsules, mature during the later months of the year and finally burst and shed the spores in Spring. The male organs — *antheridia* or sperm-sacs — are produced on special plants, which have small leaves and usually occur towards the upper portion of the patch on the trunk, higher up than the plants which produce the female organs—*archegonia* or egg-sacs. The antheridia are usually in pairs, each pair being protected by a pocket-like leaf; each antheridium is nearly globular and has a slender stalk (*See* Figure 7, A, B.). The cells forming the upper part of the antheridium are elongated and arranged radially (*See* Figure 7, C.); when the ripe antheridium absorbs water these long cells are forced apart by the swelling of the enclosed sperm-cells, and leave an opening through which the male cells or sperms escape. The archegonia are formed in a group of two or three at the ends of the branches, surrounded by a tube-like sheath which later becomes wide and egg-shaped (*See* Figure 7, D to F.); protected by this sheath and by the adjacent leaves, the archegonia are kept moist until ready for fertilisation. The ripe archegonium is flask-like, with a central series of cells, of which the lowest is the egg; all these central cells, except the egg itself, become disorganised and gummy, absorbing water and oozing out of the neck as a slimy liquid, which attracts the sperms. The latter swim, by means of their two fine lashing threads (*cilia*) to the ripe archegonium, and a sperm finally fuses with the egg; the position of the male plants, at the top of the patch on the tree trunk, helps to ensure fertilisation, since the sperms can be washed down by rain or dew and thus brought near the archegonia.

The details of development of the fertilised egg (shown in Figure 7, G to L.) need not be described. The final result is a small pear-shaped fruit, the swollen upper portion (capsule) containing the numerous spores while the stalk ends in a sucker-like organ which absorbs food from the parent plant; the swollen lower part of the archegonium keeps pace with the growth of the fruit and forms a close-fitting sheath around it.

The mechanism by which the spores are shed in *Frullania* is very striking and beautiful. Figure 8 is from a photomicrograph of a fruit which had just opened and scattered its spores. In Spring, the short stalk of the fruit elongates and thrusts the spherical dark-brown capsule through the archegonium sheath and a little beyond the opening of the outer sheath. Then the capsule splits suddenly into four pieces, by as many slits running from the top down to the bottom; these pieces spring backwards, and the minute spores are flicked out in a shower, to a distance of as much as six inches. How is this energetic discharge, or explosion, of the capsule brought about? To answer this question we must examine the capsule a little more closely. When the "explosion" is over, we see a number of curious threads, or elaters, attached to each valve, near its

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tip. Each elater (*See* Figure 8, Figure 9, D.), is like a long miniature trumpet, and contains a spirally coiled fibre, and in sections of the intact capsule we find that the elaters run from the roof to the floor of the cavity, and that they alternate regularly with rows of spores (*See* Figure 9, A.).

The sudden bursting open of the capsule is a little difficult to analyse, unless we slow it down by drawing glycerine under the cover-glass while examining a ripe but as yet unopened capsule with the microscope. As the glycerine abstracts the water from the capsule, the latter splits into the four valves, and the elaters, besides moving outwards with the valves to which they are fixed by their narrow upper ends, move independently as they lose water, and by their hygroscopic movements help to loosen and fling out the spores. The examination of young capsules shows that the alternating elaters and rows of spores are laid down at a very early period, in an extremely regular manner (*See* Figure 7,K,L.).

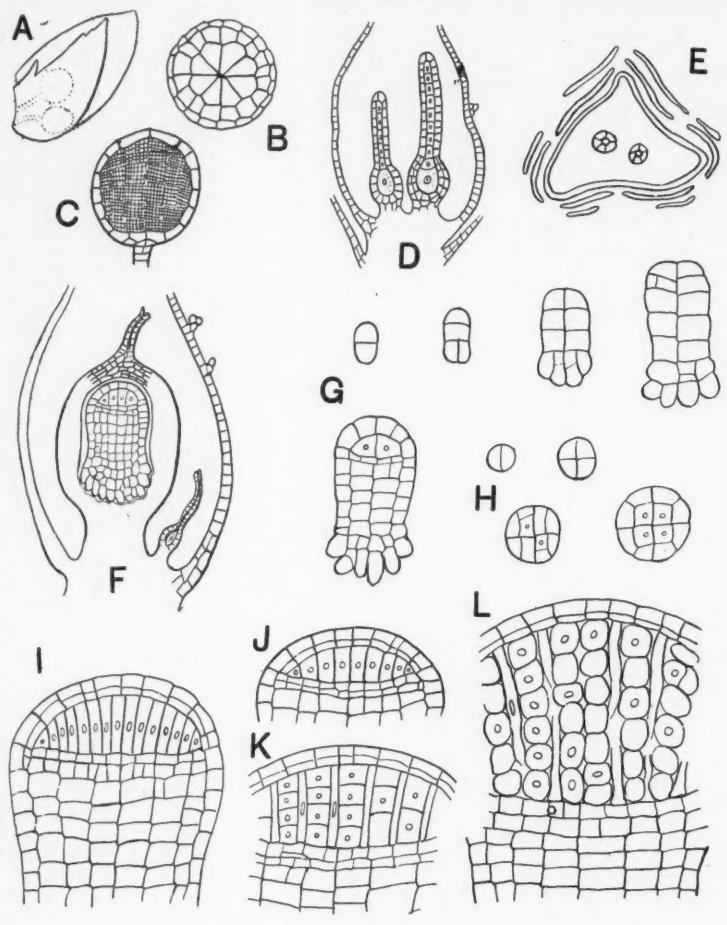

FIGURE 7. *Frullania dilatata.*

A, a male bract, from ventral surface, showing two antheridia; **B, C**, antheridium in optical view and in longitudinal section; **D**, longitudinal section of perianth with two archegonia; **E**, transverse section of same; **F**, longitudinal section showing embryo in fertilised archegonium, with unfertilised archegonium on the right; **G**, a series of longitudinal, and **H**, a series of transverse, sections of embryos of different ages; **I, J, K, L**, longitudinal sections of older sporogonia, to show development of spores and elaters.

It is interesting to note how the structure of the wall of the capsule helps in bringing about the forcible ejection of the spores, which are jerked out and thus scattered to a distance from the parent plant, besides having a better chance of being carried off by air-currents than would be the case if the capsule opened slowly, as it does in the majority of liverworts. The capsule wall consists of two layers of cells. The cells of the outer layer have thick rod-like fibres on their side-walls, especially at the corners (*See* Figure 9, C.); on the walls of the inner layer there is an irregular network of thickening fibres. Hence, as the capsule dries up, the less strongly thickened outer layer will shrink much more rapidly than the inner layer, and eventually the tension thus set up results in the bursting of the capsule-wall along four lines—marked out at an early stage in the development—where the cells are unthickened. The action of each valve of the *Frullania* capsule may be compared with that of the ring of thickened cells in the spore-case of a fern; the result of drying is the same in both cases—the parts which were curved inwards suddenly straighten and curve outwards, bursting the capsule and flicking out the spores with considerable force.

The spores have already begun to germinate while inside the capsule, so that each consists of a small oval plate of cells. On reaching a suitable place, the young plant puts out a few rooting hairs and begins to grow into a leafy shoot; the first few leaves are very small and simple and have no pitchers, the earliest under-leaves being represented only by a tuft of rooting hairs—as we have seen, the rooting hairs of the mature plant grow out from the under-leaves.

From this brief sketch* it is hoped that readers interested in plant life may be attracted to the study of the liverworts. There is, unfortunately, no illustrated book on the British liverworts except Pearson's large and expensive work (*Hepaticae of the British Isles*, Lovell Reeve); but descriptions are given in Lett's *British Hepatics* (Sumfield, Eastbourne, *7s. 6d.*) and there is a handy *Key to the British Hepatics* by Macvicar (*9d.* post free from V. T. Sumfield, Station Street, Eastbourne). The only book dealing with the general morphology of

*Based on the writer's detailed article, Notes on Yorkshire Bryophytes (iv) *Frullania* and *Jubula*. *The Naturalist*, *1907*.

the liverworts that can be recommended is Campbell's *Mosses and Ferns*, in which the development of several liverworts is dealt with in detail, though little attention is paid to their biology.

However, the only method by which one can gain real knowledge of these elegant plants is to select a few types and study them indoors and out of doors all the year round—some of the commoner species are readily identified from Macvicar's *Key*, and a general account of these, with illustrations, is given in Vol. IV of *The Book of Nature Study*, which is edited by Professor J. Bretland Farmer, F.R.S.

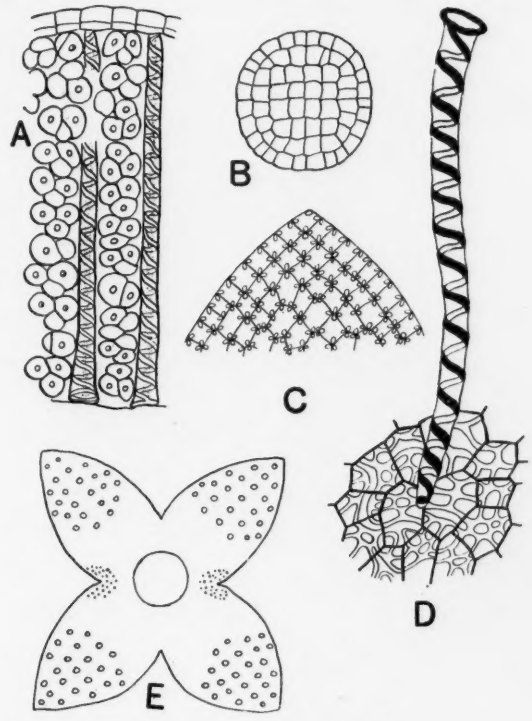

FIGURE 8. *Frullania dilatata.*

A, longitudinal section of well-grown capsule, with spore-mother-cells dividing; **B**, cross-section of stalk; **C**, part of wall of capsule (upper end of one of the four valves) seen from outer surface; **D**, part of inner surface of capsule-wall, with an elater; **E**, diagram showing the arrangement of the elaters on the four valves of the capsule-wall, as seen from above.

FIGURE 9. *Frullania dilatata.*

End of a female branch with capsule, which has exploded and shed the spores, after having (by the elongation of the seta), broken out of the calyptra and the perianth. The calyptra, bearing the withered archegonium-neck, can be seen inside the perianth.

THE ROYAL MICROSCOPICAL SOCIETY.

ON April 20th, Mr. E. J. Spitta, M.R.C.S., presided, and Dr. Hebb exhibited samples of "Solmedia," *i.e.*, solid media, which had been devised by Mr. Chopping, Laboratory Assistant at the Westminster Hospital, to supersede the ordinary methods of making culture media. Another device of Mr. Chopping's exhibited was a drop-bottle for reagents which was a modification of Schuster's alkalimeter. It had a very broad base to prevent it from being upset and had a nipple attached to a neck by which the flow of the contents could be regulated. Dr. Hebb called attention to a new cedar-oil can. It was simply the ordinary oiler of a typewriter, but was much more convenient than any of the numerous cedar-oil bottles that had been invented. He also introduced to the notice of the Fellows, Burri's Indian ink method of demonstrating *Spirochaete* and other organisms without the aid of any of the recently devised arrangements for dark ground illumination.

Mr. O. W. Wentz exhibited transparent zoological and anatomical specimens prepared according to Prof. W. Spalteholz's process.

Mr. Nelson had prepared a paper on "Critical Microscopy," in response to numerous requests to publish a description of the method of obtaining a critical image. He said that when he began microscopical work, the leading microscope makers supplied a drawer full of various illuminating apparatus which at that time was considered necessary in order to obtain the best results. He made himself proficient in the use of these, but abandoned them with the exception of a silver side reflector and a few lieberkuhns, when he perceived the advantage of the large axial-cone. An axial cone as large as that now used has only been possible since the introduction of the apochromatic system in 1886. Old object glasses would not stand it. In those days the leading microscopists studied diatom structure with oblique light obtained by the use of swinging sub-stages or other devices and the large axial cone was received unfavourably, but at length it has become generally recognised as the correct means of obtaining a critical image. The author described the image of an object as being critical when it had been obtained by means of an objective of fine quality which had been placed in correct adjustment for that object, and when the illumination was critical. An object was said to be illuminated critically when it was placed at the apex of a solid axial cone, the aperture of which was not less than $\frac{3}{4}$ of the N.A. of the objective. He then described the method of arranging a microscope for critical illumination, concluding with examples and some remarks on the examination of bacteria upon a dark ground.

THE FACE OF THE SKY FOR MAY.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.35 and sets at 7.19; on the 31st he rises at 3.52 and sets at 8.3. Sun-spots and faculae may usually be seen on the solar disc. The positions of the Sun's axis, equator, and heliographic longitude of the centre of disc are shown in the following table :—

Date	Axis inclined from N. point.	Centre of Disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May 1 ...	24° 20'W	4° 5'	290° 19'
,, 6 ...	23° 22'W	3° 34'	224° 14'
,, 11 ..	22° 15'W	3° 1'	158° 7'
,, 16 ...	20° 53'W	2° 27'	91° 59'
,, 21 ...	19° 25'W	1° 52'	25° 51'
,, 26 ...	17° 47'W	1° 17'	319° 42'
,, 31 ..	16° 0'W	0° 41'	253° 32'

There is a total eclipse of the Sun on the 9th, visible between Australia and the South Pole; at Hobart, Tasmania, totality lasts three minutes.

THE MOON :—

Date.	Phases.	H. M.
May 2 ...	☾ Last Quarter.	1 30 p.m.
,, 9 ...	● New Moon.	5 33 a.m.
,, 16 ...	☽ First Quarter.	2 13 a.m.
,, 24 ...	○ Full Moon.	5 39 a.m.
,, 31 ...	☾ Last Quarter.	10 25 p.m.

There is a total eclipse of the Moon on the morning of the 24th, but unfortunately only the early portion of the partial phase is observable in this country, since the Moon sets at Greenwich 10 minutes after first Contact with the Shadow.

The times are as follows :—

First Contact with the Penumbra, May 24th, 2.33 a.m.
First Contact with the Shadow ,, ,, 3.47 a.m.
Beginning of Total Phase ,, ,, 5.9 a.m.

The first Contact with the Shadow occurs at 84° from the N. point of the Moon's limb towards the East.

The Moon sets at Greenwich at 3.57 a.m.

OCCULTATIONS,—No occultations of naked eye stars are visible from this country during the month.

THE PLANETS.—Mercury (May 1st, R.A. $3^h\ 53^m$; Dec. N. 22° 57'; May 31st, R.A. $3^h\ 56^m$; Dec. N. 17° 15') is a morning star, in Taurus, setting at 9.32 p.m. on the 2nd, when he is at greatest easterly elongation of 20° 55'. The elongation is a somewhat favourable one and the planet should readily be discerned low down in the N.W. portion of the sky soon after sunset. In the telescope the planet appears crescent, 0·35 of the disc being illuminated, whilst the apparent diameter is 8″.

Later in the month the planet is unobservable, being in inferior conjunction with the Sun on the 25th.

Venus (May 1st, R.A. $23^h\ 40^m$; Dec. S. 2° 57'; May 31st, R.A. $1^h\ 41^m$; Dec. N. 8° 12') is a morning star, in Pisces, rising at 2.50 a.m. on the 15th.

Mars (May 1st, R.A. $5^h\ 58^m$; Dec. N. 24° 48'; May 31st, R.A. $7^h\ 20^m$; Dec. N. 23° 29') is an evening star, in Gemini, setting after 11 p.m. throughout the month. On account of his small apparent diameter the planet is practically out of range for useful observations to be made.

Jupiter (May 1st, R.A. $12^h\ 25^m$; Dec. S. 0° 59'; May 31st, R.A. $12^h\ 19^m$; Dec. S. 0″ 31') is a very conspicuous object in the evening sky, exceedingly well placed for observation, and due South about 9 p.m. near the middle of the month. The planet is describing a retrograde path near γ Virginis.

On account of his brightness, the belt markings on the disc and his bright satellites, this is the easiest and most interesting planet to observe in small telescopes. The polar flattening is also a noticeable feature since the equatorial diameter is 41″.2 and the polar diameter 2″.7 smaller. The rapidly moving satellites present a diversity of configurations in the same evening; the following table gives their principal phenomena observable before midnight.

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
May				May				May			
2	III.	Tr. I.	8 32	9	III.	Tr. I.	11 59	20	I.	Sh. E.	11 20
	III.	Tr. E.	10 57	11	I.	Tr. I.	11 48		III.	Ec. R.	11 42
	III.	Sh. I.	11 28	12	I.	Oc. D.	8 56	23	II.	Sh. E.	10 32
4	I.	Tr. I.	10 1	13	I.	Sh E.	9 25	27	I.	Tr. I.	9 54
	I.	Sh. I.	10 47	14	II.	Oc. D.	9 8		I.	Sh. I.	11 0
5	I.	Ec. R.	10 8	19	I.	Oc. D.	10 45		III.	Oc. R.	11 24
	II.	Tr. I.	11 50	20	III.	Ec. D.	9 30	28	I.	Ec. R.	10 21
7	II.	Ec. R.	11 5		I.	Tr. E.	10 19	30	II.	Sh. I.	10 25
									II.	Tr. E.	10 52

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (May 1st, R.A. $1^h\ 47^m$; Dec. N. 8° 41'; May 31st, R.A. $2^h\ 1^m$; Dec. N. 9° 54') is a morning star, in Pisces, rising about 3.30 a.m. near the middle of the month.

Uranus (May 16th, R.A. $19^h\ 49^m$; Dec. S. 21° 37') rises about midnight near the middle of the month. The planet is not well placed for observation, as he is situated low down in Sagittarius.

Neptune (May 16th, R.A. $7^h\ 14^m$; Dec. N. 21° 42') is observable in the North-West portion of the evening sky, about half-a-degree South of the star δ Geminorum; on the 15th he sets about 11.40 p.m.

The planet is difficult to identify among the numerous small stars appearing in the same field of view, as it requires a high power (about 300) and good definition to distinguish his disc; he can, however, be detected by his relative motion if observations be made on successive nights.

METEOR SHOWERS :—

The principal shower during May is that of the *Aquarids*. This may be looked for between May 1 to 6; the radiant being in R.A. $22^h\ 32^m$ Dec. S. 2°, near the star η Aquarii.

TELESCOPIC OBJECTS :—

DOUBLE STARS.—α Librae, XIV.^{h} 46^m, S. 15° 40', mags. 3, 6; separation 230″; very wide pair.

σ Coronae, XVI.^{h} 11^m, N. 34° 8', mags. 6, 6½; separation 5″.2; binary.

α Herculis, XVII.^{h} 10^m, N. 14° 30', mags. 2½, 6; separation 5″. 0. Very pretty double, with good contrast of colours, the brighter components being orange, the other blue.

δ Herculis, XVII.^{h} 11^m, N. 24° 57', mags. 3, 8; separation 14″.

CLUSTERS.—M13 (cluster in Hercules) is situated about one-third the distance from η to ζ Herculis, and is just visible to the naked eye. It is a globular cluster, and with a three or four inch telescope the outlying parts of the cluster can be resolved into a conglomeration of stars.

THE CONSERVATION OF MASS.

By ALFRED W. PORTER.

(Continued from page 123.)

ELECTROMAGNETIC MASS.

As soon as it is realised that a moving electric charge behaves like a current, and has therefore a magnetic field surrounding it, so soon must it be evident that its energy cannot consist merely of the kinetic energy as usually reckoned, depending only upon the mass and velocity of the moving body. For the existence of a magnetic field implies the existence of magnetic energy. The total amount of this for an ordinary closed current is known, but there is nothing which decides absolutely as to where this magnetic energy resides. Maxwell, however, showed that the correct total amount is obtained by supposing it distributed throughout the space surrounding the current, the amount in any small unit volume being proportional to the *square* of the magnetic force there. Employing ordinary units the amount in question is given by the formula

$$\frac{\mu H^2}{8\pi}$$

where μ is the permeability of the medium and H the magnetic field. There are difficulties connected with assuming this value ; but it may at once be stated that modern theory assumes its truth, and this can only be tested by the satisfactoriness with which any conclusions that may be come to are verified in actual experience.

It will be useful in the first place to see in a general way how this magnetic field arises in the case of a moving charge.

We will suppose the charge to be moving so slowly that any changes introduced by the motion are not sufficiently great appreciably to alter the electrostatic force surrounding the charge. In the case of the charge on a small sphere the direction of this force is at any point along the radius through the point ; the lines of force radiate outwards like the spokes of a wheel. When the motion occurs these lines will move along with the charge at the centre without any other alteration if the velocity is sufficiently small.

Take now an imaginary circle and place it with its plane at right angles to the motion. Some of the lines of force will thread through this circle. A very little consideration will show that if the circle remains fixed while the charge moves the number of the radiating lines of electric force which thread through it will change from moment to moment.

Now it is the distinctive feature of Maxwell's theory that he assumed that whenever such a change occurs there will be on the whole a magnetic force acting along the circumference of the circle. It was merely a guess on Maxwell's part, but it has proved to be such a successful one (especially in connection with the explanation of Hertzian waves, such as are employed in wireless telegraphy), that it has completely ousted every other theory. The mode in which the magnetic force is calculated is to treat the rate of change of the number of lines through the circle as equivalent to a current, *i.e.*, as producing a magnetic field equal to that due to a numerically equal

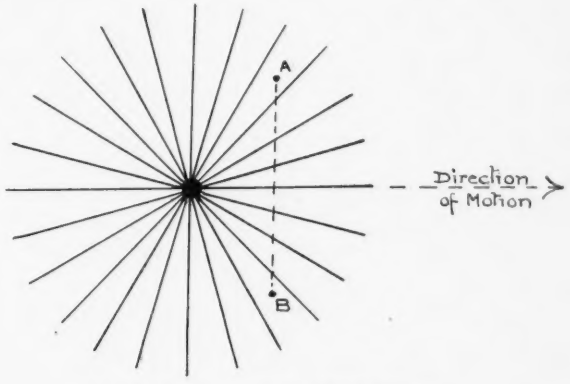

FIGURE 1. The imaginary circle.

current. Worked out in this way the magnetic field is given at any point by the expression

$$\frac{e\,u}{r^2}\sin\theta$$

where r is the distance of the point from the moving charge and θ the direction of the line joining the point and the charge. The magnetic lines which represent the direction of the field are circles surrounding the line of travel of the charge. It is easy to see that these lines, as well as the electrostatic ones, must be carried with the charge, for the value of the magnetic field will always have the same value at a given distance from the charge.

From the energy point of view we have therefore to take into account :

(i). The ordinary mechanical energy, $\frac{1}{2}mu^2$.

(ii). The electrostatic energy, $\frac{1}{2}\frac{e^2}{a}$ where a is the radius of the charged sphere.

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(iii). The magnetic energy measured in any unit volume by the expressions $\frac{\mu H^2}{8\pi}$ or $\frac{\mu}{8\pi}\left(\frac{e}{a^2} u \sin\theta\right)^2$; or measured in total amount by the expression obtained by summing up such quantities as this for every unit volume into which the whole space outside the charge can be divided up. The expression which gives the total amount is $\frac{1}{3}\mu\frac{e^2}{a}u^2$

Now two of these portions of energy depend upon the velocity, namely the first and third. Together they add up to

$$\frac{1}{2} m u^2 + \frac{1}{3}\mu\frac{e^2}{a}u^2$$

$$\text{or } \frac{1}{2}\left(m + \frac{2}{3}\mu\frac{e^2}{a}\right)u^2$$

It will be observed that in the second form the equation is written with a term added to the mass. Let us suppose that an experiment be arranged to measure the inertia of the charged body; what will be the value determined? Will it be *m* simply—that is, the inertia if there were no charge; or will it be the larger quantity $\frac{2}{3}\mu\frac{e^2}{a}$? To answer this question it must be emphasized that the second term represents energy as well as the first, and that to give a velocity to the body this energy requires to be imparted. A greater force will therefore be necessary on account of the charge, to give any particular acceleration to the body. But this is only equivalent to saying that the inertia is greater. The second term $\left(\frac{2}{3}\mu\frac{e^2}{a}\right)$ does not enter into the equation in a way that merely simulates inertia; it *is* inertia, indistinguishable in kind in any mechanical way, as long as the charge remains constant, from the ordinary inertia of the body. *It is this total inertia which is measured by the deflections of a cathode stream.* In our first chapter methods of defining inertia in terms of measurements were described. This additional term would stand the test of any such experiments. It is called electromagnetic inertia from the mode in which it originates. It does not differ mechanically from the ordinary inertia except that it can be destroyed by discharging the body, while no means has been obtained for altering the unelectrical inertia. Its value was first calculated in 1881 by Sir J. J. Thomson (though with an erroneous coefficient) to whom so much of this subject is due; the numerical coefficient was put right by Oliver Heaviside in 1885.

Here then we have a result which was not contemplated in the early statements of the conservation of mass. But this is not all. We have stated that in obtaining this result the velocity is assumed to remain small; the object of this limitation being to ensure that the electrostatic field will be carried on unchanged. But no action is ever produced without a reaction being felt by the prime mover: In the present case this implies that if the moving electric field produces a magnetic field there will be a necessary change in the electric field itself. There is no difficulty in seeing how this is brought about. The magnetic field at any point fixed in space, changes as the moving charge sweeps past. But by the ordinary law of induced currents this change involves the existence of an induced electric field; thus the original electrostatic field is disturbed, and the result obtained for the electromagnetic mass is only an approximate one. It is not perfectly easy to allow for this disturbance, and, moreover, it requires special assumptions to be made in regard to how the electricity is distributed in the moving body before a definite result can be reached. But the upshot is that it turns out that the electromagnetic energy is not really proportional to the square of the velocity, and that, therefore, the analogy with ordinary kinetic energy is not so complete. We may still write it as $\frac{1}{2}$ x coefficient x u^2, but the coefficient will not be a constant. *The electromagnetic mass depends upon the velocity with which the particle moves.*

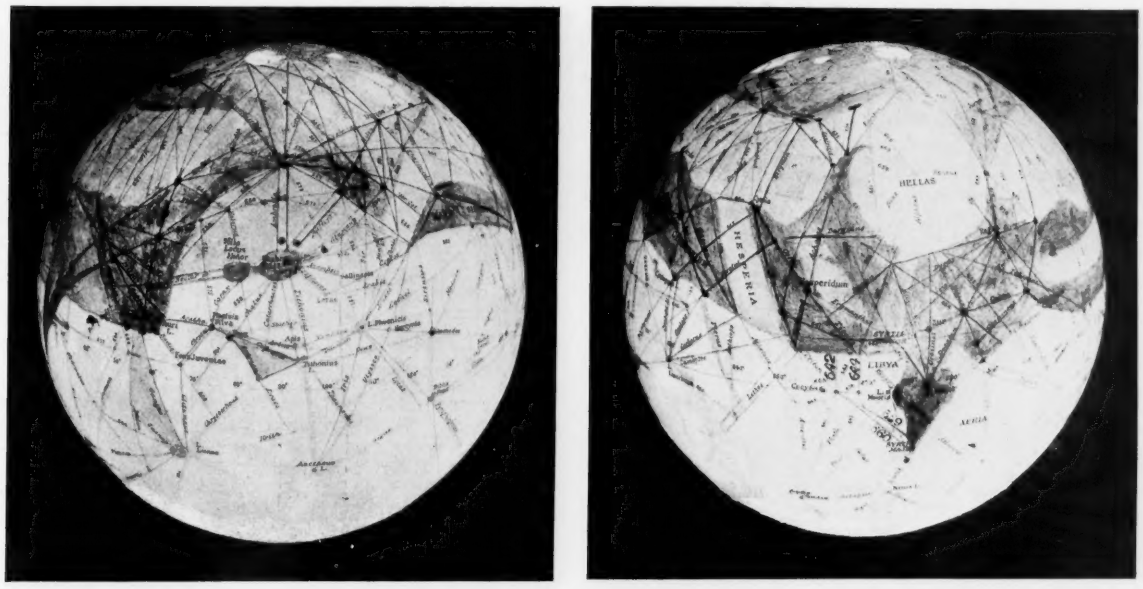
THE MARKINGS ON MARS.

PROFESSOR LOWELL'S NEW CANALS.

IN the pages of "KNOWLEDGE" the reasons for doubting the objective reality of the Martian Canals have so often been stated that it is hardly necessary to explain that the objection is directed not against the existence of a number of apparently straight lines on Mars, but against the idea that these are of such a character as to make the suggestion of an artificial origin for them a probable one. Professor Percival Lowell's argument is, on the other hand, that the appearance of these markings; their regularity; their apparent relations to one another, and to the seasonal changes on the planet—are all such as to leave little escape from the conclusion that they are veritable artificial structures. In short, if, as he says, the Martians were reduced to extremities for a water supply; if they wished to utilise what water they had for purposes of irrigation—then these are the kind of structures which might exist on the planet; and which would furnish the spectacle which is visible to those who watch the planet. The question, therefore, finally resolves itself into a settlement of the point—whether Professor Lowell

and his assistants at Flagstaff Observatory deceive themselves in supposing the Planet Mars to be covered with a network of canals, of almost as fine a mesh, comparatively, as a veil on a lady's face. Do they see these five hundred canals, or do they deceive themselves? It will be admitted that there is some force in Professor Lowell's suggestion that he, who has seen the canals, has as much right to credibility as the gifted objectors who have not seen them.

That being the case, we are happy to take this opportunity of reproducing two photographs of globes



LONGITUDE 90° LONGITUDE 270°

TWO VIEWS OF A GLOBE OF MARS MADE BY PROFESSOR LOWELL IN 1909.

The Figures 642 and 649, 659 and 660 represent lines of new Canals.

of Mars which he exhibited recently, during his lecture at the Royal Institution, on Friday, April 8th. One of these represents the canals, the features of which have been observed at Flagstaff during 1909; the second shows two canals which have never appeared on any previous charts of the planet, and which, therefore, Professor Lowell believes to be new structures on Mars. If new, then they must have been recently constructed. If they have been recently constructed a reasonable assumption is that their structure is artificial.

Professor Lowell exhibited to the audience at the Royal Institution a number of actual photographs of Mars. These photographs, as original images, are only five millimetres in diameter—about the size of the head of a tin tack; they were magnified for lecture purposes to about two hundred diameters. Notwithstanding their delicacy, these photographs registered the first appearance of snow on the Polar Cap of Mars last year (Nov. 16th); and they showed quite clearly the slightly eccentric position of the South Polar Cap. But Professor Lowell claimed for them a still more remarkable degree of minute precision. One of them, he observed, would give a sight of the great new canals that appeared in Mars last September in a region of the planet where no canals had ever been seen before.

"On September 30th last, when the region to the East of Syrtes Major came round again after its periodical hiding of six weeks owing to the unequal days of the Earth and Mars, two imposing canals were seen leading up from the Syrtes to the south-east, which had not been there at the preceding presentation. Research showed that not only had they never previously been seen, but that they could never have existed as such before. The long and full records of Flagstaff Observatory, extending over fifteen years, made it possible to be absolutely sure of this. Yet these canals with several subsidiary ones fitted with the general canal system as if they had always made part of it."

Professor Lowell showed a large drawing, which exhibited the new canals in a much more convincing way than the photographs; but that was not, and is not, an unfair method of establishing their validity and reality, because, as he very truly says, an eye trained to looking at planets sees at least ten times as delicately as the photographic film. At present the means of photographing planets do not enable us to make the best possible use of the exceedingly small amount of light reflected from the planetary discs. Professor Lowell went on to say that the birth of the new canals was not only established by the previous drawings of the planets (which showed no such canals) but all the photographs taken in previous years testified to the same unheralded advent.

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NOTES.

ASTRONOMY.

By an F.R.A.S.

"SO-CALLED CRATERS OF THE MOON."—Professor T. J. J. See arrives at a conclusion, satisfactory to himself, that the origin of the so-called craters on the surface of the Moon is not volcanic, but due to the impact of bodies, which he calls satellites. The idea is not new, being about two hundred and fifty years old; it was revived by Proctor in 1873 and written upon by the geologist, G. K. Gilbert, in 1892; Humboldt, Schmidt, and others were sceptical of the purely volcanic nature of the craters; but the impact theory has not yet found acceptance, either by astronomers or geologists. Mr. See adduces evidence in support of his contentions; it appears to us that his views with regard to both small and large craters, and their very frequent superposition, as well as in connection with the occurrence, of small craters on the ruins of large ones—which he assumes are not from eruptic causes—are inconclusive; indeed, from geological experience, might equally prove the contrary to his contentions. In his arguments he states that the whole lunar surface or moon itself, was formed by accretion of cosmic dust and impact of bodies; and that the surface never did experience true eruptive phenomena, such as we know occurs, or has occurred, on the earth. In concluding his arguments in favour of the impact theory he says we may dismiss the old volcanic theory once for all as false and misleading, and may look upon our satellite as a battered planet. We think that most astronomers and geologists will maintain their adherence to the volcanic rather than the impact theory.

CROSSLEY REFLECTOR.—Early in the year the Crossley Reflector at the Lick Observatory was dismounted, and the bearings of the declination and the polar axes were taken down to San Josè to be bored out for the new system of roller-bearings, which are of the anti-friction type; the instrument was ready for work again in ten days, and it is now possible to move the telescope in declination with a weight of only four pounds, and about ten pounds is required to move it in right ascension: the moving parts weigh six tons—a fine achievement.

HALLEY'S COMET.—This ephemeris, for Greenwich noon, has been computed by Dr. Smart, and is taken from the *Astronomische Nachrichten*, No. 4379, and communicated by Mr. A. C. D. Crommelin.

1910	R.A. H. M. S.	Dec.	1910	R.A. H. M. S.	Dec.
May 6 ..	0 3 6	+ 9° 5′	May 20 ...	5 3 23	+ 19° 8′
,, 10 ...	0 21 35	+ 10 30	,, 21 ...	6 9 54	+ 17 40
,, 11 ...	0 29 39	+ 11 2	,, 22 ..	7 3 4	+ 15 14
,, 12 ...	0 38 32	+ 11 41	,, 23 ...	7 44 48	+ 12 40
,, 13 ...	0 50 12	+ 12 29	,, 24 ...	8 18 20	+ 10 24
,, 14 ...	1 5 47	+ 13 27	,, 25 ...	8 40 7	+ 8 31
,, 15 ...	1 24 47	+ 14 36	,, 26 ...	8 58 52	+ 6 59
,, 16 ...	1 49 52	+ 15 59	,, 27 ...	9 13 8	+ 5 45
,, 17 ...	2 23 4	+ 17 29	,, 28 ...	9 24 36	+ 4 45
,, 18 ...	3 7 19	+ 18 51	,, 29 ...	9 33 48	+ 3 50
,, 19 ...	4 3 11	+ 19 43	,, 30 ...	9 41 23	+ 3 15

This indicates that a transit of the comet across the Sun's disc will take place on May 18·6 G.M.T.

The comet is now moving towards the Sun in R.A. and Dec., and becomes very rapid after May 15th. If only we may experience in these islands a reasonable amount of freedom from cloud in the evening, after sunset, we should obtain our best view between May 20th and 30th. As we may pass through the comet's tail, should it extend to a length of fourteen or fifteen millions of miles, about the time of transit, it would be advisable to keep a good watch on the sky on May 18th-19th for any unusual phenomena, or particulars.

BOTANY.

By George Massee, F.L.S.

COMPOSITION OF THE FORESTS OF THE GOLD COAST.—Mr. H. N. Thompson deals with the geology of the Gold Coast region in *Colonial Report*, No. 66. The Flora of the Gold Coast belongs to the Zone known as the Tropical Zone, but the local distribution of the various types of vegetation found there is determined by the amount of atmospheric precipitation prevailing in any one locality. The district may be divided into three climatic types (a) Hygrophilous, (b) Xerophilous, (c) Tropophilous. These modifications are brought about by the conditions known as *physiological* moistness and dryness which do not always coincide with physical moistness and dryness. Anything that affects the available supply of moisture so as to bring about this physiological moistness or dryness is accompanied by hygrophilous or xerophilous vegetation, as the case may be. When these conditions alternate one with another with a regular periodicity we get the third or tropophilous type. This relation of plants towards water is expressed by structural characters.

Hygrophytes possess structural features that favour the exit of water absorbed by the roots. There is a weakly developed root-system, elongated axes, large thin leaf-blades, and they but rarely develop thorns. The leaves often have a long "dripping point," well developed air-containing intercellular spaces that strongly promote transpiration, and organs for excreting liquid water. The heavy showers of so called "dew-drops" so often noticed late of night or early in the morning in a tropical forest in a moist locality, mainly consist of water secreted by these organs or Hydathodes.

Xerophytes on the other hand, have to guard against extreme drought. This is accomplished by a reduction of the transpiration surface, thick cuticle, sunken stomata, and the presence of felted hairs containing much air. In addition there is usually a copious root-system and the power to orient their leaves so as to avoid insolation at the hottest and brightest time of the day. The trunk also, as in the case of the African Baobab tree *(Adansonia digitata)* may acquire a monstrous, gouty shape, with soft spongy wood, that forms a vast water reservoir.

Tropophytes are characterised by shedding their leaves at the beginning of the dry season. Periodically foliaged tropophilous trees have hygrophilous leaves but xerophilous stems. Evergreen tropophilous plants have xerophilous foliage as well as xerophilous axes and buds.

ON THE ABSORPTION OF WATER BY THE AERIAL ORGANS OF SOME SUCCULENTS.—It has long been known that water in liquid form can be absorbed by the leafy shoots of many plants, and that even the loss by transpiration of other parts of the same plant, which are not wetted, can be made good in this manner. There are also a number of cases in which water is supposed to be absorbed by means of special hairs or glands, or by means of saline excretions of the leaves. Marloth, however, has shown pretty conclusively that the saline excretions cannot serve to conduct water from rain or dew to the organs which secrete them; on the other hand, in his recent work on the Flora of the Cape of Good Hope, Marloth gives some prominence to the absorption of water by special trichomes, or hairs, of certain succulents. Some cursory experiments conducted by Dr. S. Schönland did not bear out Marloth's views on this matter, consequently Schönland describes in *Trans. Roy. Soc., S. Africa*, a more extensive series of experiments on this point.

Branches of *Mesembryanthemum barbatum* and of *Anacampseros filamentosa* were used for certain experiments. Some branches were kept dry, others had the stellate hairs on the leaves wetted daily, others immersed daily for fifteen minutes in water. Other experiments by immersing branches in a watery solution of eosin were conducted, and the summary of results is as follows :—

Mesembryanthemum barbatum, and *Anacampseros filamentosa* cannot absorb any appreciable quantity of water through their aërial organs. *Crassula cymosa* can do so to a small extent, which, however, cannot be of any practical importance under natural conditions. The marginal papillae of this species are certainly not water-absorbing organs. The experiments throw doubt on the view that many other South African succulents can absorb by means of their aërial organs sufficient water to make good the loss by transpiration.

The author points out that many of the older experiments proving that water could be absorbed under special conditions prepared for them, did not prove what would happen under *natural conditions*.

DANGERS CONNECTED WITH EATING RAW FRUIT.—A. Sartory and A. Filassier point out, in *Comptes Rendus*, the possibility of infection by bacteria and fungi through eating raw fruit. Among the species observed on grapes, strawberries and gooseberries were *Bacillus termae*, *B. Subtilis*, *Staphylococcus aureus*, *Streptococcus*, *Penicillium* and *Rhizopus*.

This state of things recalls the story told of the late Professor Pasteur, who, when dining with a friend, carefully rinsed each grape in a glass of water. In the excitement caused by a discussion as to the necessity for this precaution, the Professor absent-mindedly drank the glass of water that had been used for removing germs. No ill result followed.

THE LOCATION OF FUNGUS MYCELIUM DETERMINED BY THE HOST.—It is always given as a characteristic of the Erysiphaceae, that the vegetative mycelium is superficial on the host, except perhaps in one genus, whereas in the majority of other groups of parasitic fungi, the mycelium is immersed in the tissues of the host-plant.

Quite recently, however, E. Foex has stated in *Ann. Ecol. Agric. Montpellier*, that, in the case of *Oidiopsis taurica*, one of the Eryciphaceae, the development of the mycelium on the surface or immersed in the tissues, depends on the structure of the leaves of the host-plants. If they are hairy, as in *Mercurialis tomentosa* and *Phlomis herba-venti*, then the mycelium is superficial and abundant. In *Onobrychis sativa* on the other hand, which has simple, slender hairs, the mycelium is developed in the tissues, and sends haustoria into the mesophyll cells. The conidiophores emerge through the stomata.

By Professor F. Cavers, D.Sc.

THE ACID EXCRETION OF ROOTS.—The well-known corrosive action of roots, as demonstrated by growing seedlings in sawdust resting on a slab of limestone or marble, has within the last few years been investigated by various workers, and the discordant results obtained have led to considerable discussion. Aberson (*Jahrb. Wiss. Bot.*) has recently attacked the problem in a striking and novel manner. His experiments were based on the delicate electrometric method of Nernst for the determination of the quantity of hydrogen ions in solutions, and he found that the carbonic acid (carbon dioxide dissolved in water) present in the gum which invests the root hairs is quite sufficient in amount to explain the solvent action of the roots. If, as there seems no reason to doubt, Aberson's results are correct, this much debated question is answered—it is the carbon dioxide respired by the root (and doubtless given out by dead as well as living root-hairs) which enables the plant to make use of soil substances which would otherwise not be available for its nutrition.

THE SUSPENDED VITALITY OF SEEDS.—Becquerel has reported to the Paris Academy of Science (*Comptes rendus*) the results of further experiments on the question of the vitality of seeds. He perforated the seed coats of wheat, mustard and lucerne, dried them in a vacuum at 40° C for six months, sealed them in a glass tube exhausted to 0·002 mm. mercury, and kept them for a year. They were then submitted to the temperature of liquid air (—190°) for three weeks, and to that of liquid hydrogen (—250°) for three days. On being kept on moist cottonwool at 28° the seeds germinated in a normal manner. Becquerel finds it impossible to conceive of "life" under the conditions to which these seeds were subjected, and holds that life can be interrupted completely—not merely slowed down—with no prejudice to its resumption. In his earlier experiments Becquerel established the interesting fact that the dry coat of various seeds, for instance ordinary peas or beans, is quite air-proof—as are those of all seeds which have been definitely proved to be capable of germinating after being kept for as long as eighty years. He found that when detached pieces of the seed coats were fitted up to close the top of a tube of mercury, above a Torricellian vacuum, no air was drawn through even in many months—the micropyle itself is hermetically sealed in some way and allows no air to pass. But if the air in contact with the piece of seed coat is saturated with water vapour, the coat absorbs water and then allows air to pass by diffusion. Hence a really dry seed is apparently quite isolated from gaseous exchange with its environment.

THE EMBRYOS OF BOTRICHIUM AND DANAEA.—Until quite recently the development of a suspensor—a more or less filamentous structure by means of which the embryo plant is thrust into the nutritive tissue of the parent—was unknown in Ferns, though characteristic of the Lycopods (*Lycopodium*, *Selaginella*). A few years ago Lyon showed that one species at least of *Selaginella* has no suspensor, and that, on the other hand, a suspensor is present in a species of Moonwort (*Botrychium obliquum*)—the first recorded case of the occurrence of this organ in the Ferns. Campbell (*Ann. Bot.*) has just discovered that in another Fern—a species of *Danaea*, belonging to the Marattiaceae—the upper of the two cells formed by the first division of the fertilized egg produces a short suspensor, all the parts of the young Fern plant arising from the other cell. The real significance of these striking departures from the normal mode of development of the Fern embryo is not obvious at present, but it is noteworthy that the occurrence of a suspensor in Fern embryos is apparently confined to the two most primitive of the Fern families. It is also of special importance as an indication that too much stress has been laid in the past on the presence or absence of a suspensor—for instance, the Quillwort (*Isoëtes*) is still by many writers divorced from its close ally in all essential respects—*Selaginella*—simply because its embryo happens to be devoid of a suspensor; in Vines' *Text Book*, for instance, *Isoëtes* is placed among the Ferns, instead of being classified with *Selaginella* in the Lycopods.

THE FERMENTATION OF TOBACCO.—The "curing" of tobacco has been attributed by various writers to bacterial action, or to the action of ferments without the intervention of bacteria. Boekhout and de Vries (*Centralb. Bakt.*) have attacked the problem by methods similar to those used in their earlier work on the spontaneous heating of hay. They sealed up dry samples of cured tobacco in tubes with oxygen or air (water was in some cases added), and after a definite period of heating (at 100° or 33°, according to the purpose of the experiment) the gas in the tubes was analysed. It was found that oxidation took place at both temperatures, but more rapidly at the higher temperature; the presence of water increased the rate of oxidation. In the process carbon dioxide was liberated and oxygen fixed; the chief substances which disappeared were starch and sugars. In seeking for a possible catalysing substance tests were made with iron, which is present in tobacco. It was found that starch paste to which ferrous sulphate was added was completely converted into sugar in six days at 100°; in a similar experiment without iron salts no change occurred. The authors conclude, from their work, that the fermentation of tobacco is simply a process of

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oxidation, in which iron salts may act as catalytic agents, and that the changes involved are of a purely chemical nature, taking place without the action of either ferments or bacteria.

ULTRA-VIOLET RAYS AND PLANT LIFE.—It has been known for some time that ultra-violet light can be employed to sterilise milk, water, and other liquids containing bacteria, on account of its germ-killing power. It has just been shown by Maquenne and Demoussy (*Comptes rendus*) that the ultra-violet rays have an equally deadly effect upon green plants. The experiments were made with the mercury-vapour lamp, which yields light rich in these rays. Green foliage-leaves exposed to this light soon became brownish, owing to the decomposition of the green colouring-matter (chlorophyll) resulting on the death of the protoplasm in the leaf-cells. The action takes place chiefly in the superficial layers of the leaf, owing to the feeble power of penetration of the ultra-violet rays, the epidermis and the cells just below it being the first to show disorganisation. The writers also proved that the withering shown by the leaves of plants exposed to the direct light of the electric arc is solely due to the presence in this light of ultra-violet rays.

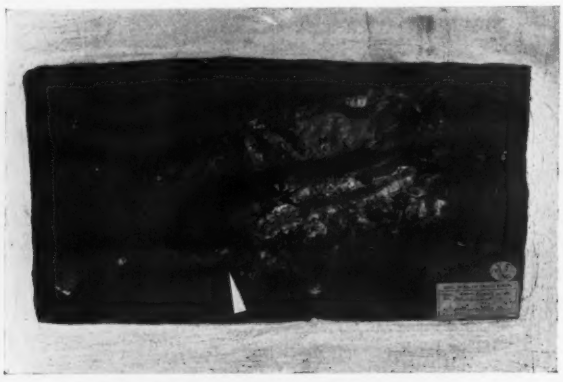
"AMBROSIA" FUNGI.—Two extremely interesting papers have recently been published by Neger (*Ber. deutsch. Bot. Ges.*) on the fungi associated with certain insects, which utilise them for food. He applies the apt term "ambrosia" to the fungus cells which the insects eat, and in one case he describes the "ambrosia galls" produced by certain gall-producing mites (*Asphondylia*), in which the insect undergoes its development from the egg to the full-grown state. The cavity of the gall is lined by a layer of fungus threads producing the ambrosia—special spherical cells; after the insect has escaped, the proper spores of the fungus are produced on the outer surface of the gall. Neger's observations on the fungi associated with certain wood-boring beetles (*Xyloterus*, and so on) are even more remarkable. Here the fungi form ambrosia lining the tunnels made by the insects, and various "weeds" occur in the "fungus garden" in the form of yeasts, bacteria and foreign fungi that infect the wood, but have no part in producing the edible cells. The larvae of these beetles confine their borings to the sap-wood, where the fungi flourish best, and the fungus threads bring to them the rich food abstracted from the living wood cells, hence these favoured larvae do not depend upon the comparatively poor nourishment afforded by the hard woody tissue itself.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

THE CHEMISTRY OF SEPIA.—Readers of Dean Buckland's life may remember that on one occasion he showed Flaxman, the artist, a sepia drawing, the colour of which was so rich that Flaxman was anxious to know the name of the manufacturer and of the pigment, and was disappointed on learning that it had been made by a prehistoric cuttle-fish.

In spite of this testimony to the permanence of sepia when compressed into a compact mass in the ink-sac, the pigment, when used as a water colour, is far from being permanent, as was shown by experiments made some years ago by Sir William Abney. Papers coated with eight washes of various pigments were exposed to the light in sealed tubes from which the air had previously been exhausted, and it was found after two years there was perceptible diminution in the intensity of the colour in the case of sepia and four other colours. When both air and light were allowed to act upon the washes the sepia was affected to a pronounced extent.



Fossil Cuttle-fish. The White Pointer indicates the Ink-sac.

This is not surprising when we remember the complex organic nature of sepia. It was formerly held that the inky fluid secreted by the cuttle fish was only carbon in a fine state of division, associated with nitrogenous substances and with mineral salts, such as calcium phosphate; and this would explain the general belief in the permanency of sepia, since ordinary Indian ink, which is a mixture of fine carbon and glue, is quite permanent as a pigment.

One of the earliest analyses of residue in the dried ink-sac of the common cuttle fish was that made in 1815, by Prout, who found it to consist of 78 per cent. of black pigment (*melanine*), 10·4 per cent. of calcium carbonate, 2·16 per cent. of alkali chlorides and sulphate; and 0·84 of mucine.

A more recent analysis, made in 1881, by M. Girod, showed that the black pigment (*melanine*) contained carbon, nitrogen, hydrogen and oxygen; while, still later, Nencki and Sieber prepared from the pigment an acid substance to which they gave the name of *sepiaic acid*.

Specimens of the commercial dried ink-sacs, as received by Messrs. Newman & Co., have been examined by the present writer. These had a distinct fishy odour which became more pronounced on boiling the substance with water. When powder they yielded a black pigment, which contained 17·5 per cent. of water, 12·2 per cent. of mineral matter, and 8·4 per cent. of nitrogen. The powder was partially soluble in hot water, but long extraction was required to dissolve the soluble substances. The insoluble matter left on the filter amounted to 71·1 of the original powder, while the brown solution left a brown resin-like mass when evaporated.

The presence of nitrogen in the final preparations of sepia affords a ready means of distinguishing between the genuine pigment and preparations of Indian ink and other forms of carbon, which, after removal of the glue they contain, are practically devoid of nitrogen. In the case of four specimens of Indian ink examined by the writer not a trace of nitrogen was present in the insoluble powder left upon the filter after treatment of pigment with boiling water.

THE CORROSION OF BRONZE.—A recent issue of the *Gazzetta Chimica Italiana* contains an interesting investigation by Messrs. Giolitti and Ceccarelli upon the behaviour of bronze when exposed to the electrolytic action of corrosive agents, such as hydrochloric acid. From the results obtained in the experiments it appears that the differences in the behaviour of two bronzes of the same composition towards corrosive agents is mainly due to the different treatment to which the alloys have previously been subjected.

Thus a bronze containing 3·7 per cent. of tin, which had been slowly cooled, lost 11·19 per cent. in weight on treatment with dilute acid containing ferric chloride; while the loss was 13·21 per cent. under the same conditions when the alloy had been rapidly cooled; and only 10·86 per cent. when it had been annealed at 100° C.

These differences in the behaviour of an alloy after exposure to different thermal conditions correspond to differences of structure, which may easily be recognised under the microscope. Thus the speed of corrosion increases with the increase in the difference between the concentration of individual crystals near the nucleus and that of crystals towards the edge. And since such differences may be approximately estimated under the microscope, it is possible to base a judgment as to the resistance a specimen of bronze will offer to corrosion, upon the results of microscopical examination of its structure.

INDIRECT ESTIMATION OF THE FRESHNESS OF MILK.—Ordinary milk contains an enzyme which reduces hydrogen peroxide and liberates oxygen, but the amount

of that gas liberated by perfectly fresh milk (3 to 4 hours after milking) should not exceed 1·2 to 2·2 c.c. per litre. After standing for some hours, however, the proportion of oxygen steadily rises, and after 18 hours at the ordinary temperature may reach 10 to 15 c.c. This is due to the enzymic action of bacteria, and a method has been based by M. Sarthou upon the results of this test. In his opinion a fresh milk suitable for children ought not to liberate more than 2·8 c.c. of oxygen. This development of the bacterial reducing enzyme is checked by freezing the milk, but even at a temperature of 40° F. it slowly continues. Thus a milk tested after 48 hours' exposure at a winter temperature liberated 6·8 c.c. of oxygen. The method thus also affords an indirect estimation of the bacterial purity of milk.

GEOLOGY.

INTERNATIONAL GEOLOGICAL CONGRESS AT STOCKHOLM.—The circular announcing the details of the Swedish meeting of the International Geological Congress has just been distributed. The meeting commences at Stockholm on August 18th. Several questions of general interest have been chosen for special discussion, and at the same time they are problems of particular interest to students of Swedish geology. The questions include the geology of the Pre-Cambrian systems, the changes of climate that have taken place after the maximum of the last glaciation, the iron-ore resources of the world, the geology of the Polar regions and the meaning of the sudden appearance of the Cambrian fauna.

The Swedish geologists have planned a splendid series of excursions, which will permit those attending the Congress to examine all the chief places of geological interest in Sweden. The excursions to be made before the meeting takes place in Stockholm, traverse Central and Northern Sweden for the purpose of examining the region of great overthrusts, which corresponds geologically to our own North-West Highlands; the immense iron-ore deposits of Northern Sweden; the quaternary glacial phenomena and modern glaciers. One excursion, more ambitious than the rest, will give geologists the opportunity of spending ten days in Spitzbergen.

Eight excursions, following the meeting, visit all the classic sections in the Silurian beds of Götland and Scania, and the interesting Quaternary deposits, besides the numerous iron-ore deposits and peat-mosses.

SCOTTISH GRANITES.—Dr. Mackie, in a paper published in the Transactions of the Edinburgh Geological Society, gives the result of his study of a number of Scottish granites with special reference to the mode of occurrence of micropegmatite and to deviations from the normal order of crystallization of the minerals. After classifying the various types of micropegmatite and describing the abnormalities in the order of crystallization in some detail, he discusses the order of crystallization found and puts forward certain explanations, the latter constituting probably the chief interest of the paper. He finds that in granite quartz is the most aberrant mineral, its occurrence in normal position being together equal to orthoclase and plagioclase. There are two maxima of this, one in the hornblende of the hornblendic rocks, and the other in the orthoclase of the more acid rocks. The author explains this by supposing that in the molten solution the liquid hornblende is able to keep a certain amount of silica dissolved, which is forced to crystallize when the hornblende does so. Later the rest of the quartz would appear in normal position. By considering the various solubilities of the different minerals in one another, the solvent action of water, temperature variations and re-absorption due to successive crystallization, he is able to devise a scheme which will account for abnormalities in the order of crystallization. It is doubtful, however, whether hornblende can exist in a molten solution, other evidence seeming to make it more probable that hornblende comes into being only in the act of crystallization.

ZONES IN THE CARBONIFEROUS SYSTEM.—The success attending Dr. Vaughan's work in the Bristol district has given a great impetus to the zoning of the Carboniferous rocks of the British Isles. His system has been applied to the Carboniferous rocks of the whole of South Wales and the Midlands, with the result that not only have we a much fuller knowledge of the life of the period, but several interesting and important points in the physiography of Lower Carboniferous times have been ascertained. Not only has an extensive unconformity in the Carboniferous Limestone of South Wales been demonstrated, but great overlaps in North Wales and Yorkshire, previously suspected, have been proved. In the "Geological Magazine" for last month Mr. R. G. Carruthers sounds a timely note of warning, the occasion being the discovery of certain zone-fossils outside the limits of the zone in which they have hitherto been found in South Wales. He points out that the zones recently established are not based upon the presence of forms which are in true genetic sequence so much as upon a succession of unrelated faunal phases. They are, in fact, dependent on a series of physical conditions (not of necessity expressed lithologically), each of which is favourable to certain gentes only. In other words, we do not yet know the true range in time of our zone-fossils, their apparent limits in the geological succession not marking their first appearance and extinction. The zones then have not yet the same value as the graptolite zones in the Lower Palaeozoic, or the cephalopod zones in the Jurassic. Sooner or later, after leaving our type district, other areas are entered where different physical conditions have prevailed, and consequently a different succession of faunal phases is found. Herein lies the cause of many of the difficulties of correlation with the North of England, Scotland and parts of Ireland.

ORNITHOLOGY.

W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U.

BIRD PHOTOGRAPHY.—The modern development of the Camera has been productive of an enormous increase to our knowledge of the domestic economy of bird life. The Keartons, Mr. R. B. Lodge, Miss E. L. Turner and Mr. H. B. Macpherson have long since won their laurels in this field. Among the latest in the achievement of really important work is Mr. W. Bickerton, who at a recent lecture before the Selborne Society and at the Ornithologists' Club on April 20th, exhibited a very remarkable series of slides illustrating the nesting habits of birds. He showed some wonderful pictures of Great Crested Grebes, Reed Warblers and Reed Buntings, which not only entitled him to rank among the foremost of our Nature photographers, but also proved him to possess a keen observation and power of interpretation.

LANCEOLATED WARBLER IN LINCOLNSHIRE.—Mr. G. H. Caton Haigh has added a new bird to our ever-growing list of British Birds. This is the Lanceolated Warbler, *Locustella lanceolata*, which he shot on the sea-bank at North Cotes, Lincolnshire, on November 18th, 1909. This bird has only twice been recorded in Europe, once from North Russia, and once from Cattaro, Dalmatia. Mr. Caton Haigh gives a short but interesting account of this new addition in "British Birds" for April.

CORSICAN WOODCHAT IN KENT.—Another new British bird is the Corsican Woodchat, *Lanius senator badius*, which Mr. Claude B. Ticehurst, in a long note in "British Birds," for April, records, was shot so long ago as June last (1909) by a shepherd, in Romney Marsh. The bird is to be seen in the collection of Mr. J. B. Nichols, and was exhibited at the Ornithologists' Club in February last.

LESSER KESTREL IN YORKSHIRE.—The tenth record of the occurrence of the Lesser Kestrel (*Falco cenchris*) in England and the third in Yorkshire is made by Mr. Claude B. Ticehurst in "British Birds" for April. This bird was shot by Mr. Ticehurst on October 14th, 1909, on the Holderness Coast, and was an immature male.

SPOTTED SANDPIPER IN SUSSEX.—An immature female Spotted Sandpiper (*Totanus macularis*), was shot by Mr. Ayling, at Shoreham, Sussex, November 27th, 1908. Mr. J. B. Nichols places the fact on record in "British Birds,"

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for April, and Mr. H. F. Witherby supplements this note by a photograph of the underside of the wing, showing the characters whereby this kind may be distinguished from the Common Sandpiper, which it resembles.

RARE BIRDS IN THE ISLE OF MAY.—The current issue of the "Annals of Scottish Natural History" contains a most interesting record of the further observations of the Misses L. J. Rintoul and E. V. Baxter, when on their annual visit to the Isle of May (Firth of Forth). The more remarkable are the following:—

Eastern Pied Wheatear (*Saxicola pleschanka*), a female taken October 19th, 1909.

Barred Warbler (*Sylvia nisoria*), a male, September 13th.

Yellow-breasted Warbler (*Phylloscopus superciliosus*), at least 10 specimens seen during September and October.

Red-breasted Flycatcher (*Muscicapa parva*), September 25th.

Scarlet Grosbeak (*Pyrrhula erythrina*), a female, September 13th.

Little Bunting (*Embeiza pusilla*) one September 26th, Hoopoe in Co. Cork. Mr. H. W. Toulmin writes to "The Field" April 2nd to say that on March 27th and the day following, he had the good fortune to watch a Hoopoe feeding on his lawn. As the Editor pertinently remarks, this bird is a summer visitant to these Islands and would breed (and has bred) if only it were allowed to do so.

MARCH CUCKOOS.—Mr. H. A. Bryden in "Country Life" April 29th revives the old theme of March Cuckoos, remarking that a competent observer had reported the arrival of the Cuckoo near Chalvington, East Sussex, on March 8th. Mr. Bryden contends that although such records have commonly been disallowed, there is good reason to believe that many of these records are trustworthy. He points out that such early arrivals would find at least a sufficiency of food in the shape of Caterpillars of the Tiger-moth.

The "Field," April, contains the following records:—

Chiff-Chaff, near Bath, March 5th, Salcombe, Devon, March 23rd.

Willow Wren, Midford, Bath, March 19th.

Wheatear, Pembroke, March 15th, Padstow, Cornwall, March 25th.

Garden Warbler, Stroud, March 15th.

Blackcap, Netley, April 4th.

Wryneck, Weybridge, March 2nd, Whitesand, Cornwall, March 26th.

House Martin, Bridgnorth, March 31st.

Swallow, Plymouth, April 11th, Stroud, April 11th.

Sand Martin, Penally, Pembroke, March 28th.

Cuckoo, Padstow, Cornwall, April 9th.

Stone Curlew, Imber Down, Wilts, March 27th.

PHYSICS.

By ALFRED W. PORTER.

A CURIOUS CASE OF ELECTRIFICATION.—In a communication to "Nature," April 14th, Mr. Walter Jamieson calls attention to a curious case of electrification. If two narrow strips of celluloid in contact are rapidly pulled between the fingers they both become electrified, not only in their outside surfaces where the friction of the fingers produces a negative electrification of the celluloid, but also on their inner surfaces, and in this case one of them becomes negative and the other positive. If care be taken to give a definite curvature to the strips while being rubbed it is the concave inner surface which becomes negative, the convex one positive. Thus the phenomenon depends upon which surface is compressed (concave) and which extended (convex). But it is remarkable how little curvature is necessary; it seems to be impossible to draw the slips between the finger and thumb, keeping them as straight as possible, without producing such strong electrification that one piece may be held up by the other. It is well known that the vapour pressure of a fluid is greater at a convex surface than at a concave one. Thus, on the electron theory—according to which the electrons are treated as the particles of a gas dissolved in the solid—there will be a greater tendency for the electrons to escape from the convex surface, which will be therefore left positively charged. If this is the explanation, the function of the rubbing is merely to bring the adjacent surfaces into intimate contact, one with the other.

MOTION OF FINE PARTICLES IN LIQUIDS.—One of the most characteristic properties of colloidal solutions and emulsions is that if an electric field be created between the ends of the containing tube the particles move either in or opposed to the direction of the field. It follows that the particles are electrically charged, positively when they move in the direction of the field, negatively when in the opposite direction. When the fluid, as usual, is uncharged on the whole an equal opposite charge must be attracted toward the particles in such a way that the two opposite charges may be regarded as on the coatings of a condenser; one coating being the surface of the particle, the other coating an adjacent layer of the fluid. From one coating to the other must stretch an electric field, characteristic of the particle in the fluid. A particle surrounded by a *double layer* of this kind would not be acted upon by an external electric force (except to a momentary extent) if the layer were permanent; but the outer layer is supposed to break down as the particle moves, and to be constantly replaced by a fresh layer in front; the motion will then persist. On the basis of a theory first worked out by Helmholtz, the difference of potential between the surfaces of the double layer can be calculated from the observed velocity and the viscosity of the fluid. The values found are always small, but as emphasized by Dr. W. C. McLewis in the Philosophical Magazine for April, they are *all of the same order of magnitude*. In a long series which have been examined, the largest is 0·058 (for gold particles) and the smallest is +·016 (for bismuth hydroxide). Even when the fluid medium is changed the *order* of the potential difference remains the same. Dr. Lewis naturally concludes that this potential difference is independent of the chemical nature of the particle or of the fluid in which it is immersed. To account for this result he supposes that the charges are not formed by charged electrolytic ions gathering together at the surfaces but by electrons. The ions of different solutions might be expected to exhibit differences, while electrons would be the same in every case. Dr. Lewis makes calculations, the result of which may indicate the mechanism by which the double layer is formed. An electron possesses a definite amount of kinetic energy (the same as that of a molecule of hydrogen) at a definite temperature. If we suppose that an electrine, set free with this kinetic energy, just succeeds in reaching the outer surface of the double layer before its kinetic energy is all transformed; and that when transformed it appears as the electrostatic energy of the double layer, the difference of potential can be calculated and turns out to be 0·048 volts, which is in fair agreement with the observed value.

THE STRIKING POINT OF PIANOFORTE-STRINGS.—In the same journal, Mr. G. H. Berry brings forward experimental evidence against Helmholtz's explanation of the reason pianoforte makers construct their instruments so that the hammers shall strike the strings near the fixed bridge. Helmholtz's explanation was that this practice tended to eliminate the dissonant upper partials. Hipkins had shewn that as a matter of fact the dissonant partials are not eliminated. Mr. Berry's experiments show that when the wire is struck the sounding board also vibrates *in its own period* as well as in that of the wire struck; and it appears to be the aim of the maker—which he has reached by empirical methods—to obtain the maximum effect from the string and the minimum effect from the natural period of the sounding board. This result is obtained when the point struck is about $\frac{1}{9}$ of the length of the wire from the fixed bridge.

ZOOLOGY.

BY PROFESSOR J. ARTHUR THOMSON, M.A.

PARTNER POLYPS.—Miss Winifred Coward has given, in the Proceedings of the Amsterdam Academy of Sciences (1909) a very interesting account of a peculiar hydroid which lives on the pinnules of a sea-pen or Pennatulid from the Timor sea. The hydroid, which she names *Ptilocodium repens*, grows among the polyps of the Pennatulid (*Ptilosarcus*), in fact close by their mouths. And as the hydroid has numerous defensive polyps, out-numbering the nutritive ones (which have degenerate tentacles), it may be that it confers some protective advantage on the Pennatulid on whose food-supply it levies toll.

HABITS OF THE WHITE TERN.—One of the most interesting and beautiful birds of Norfolk Island (in the Western Pacific, about nine hundred and fifty miles N.E. from Sydney), is the White Tern (*Gygis alba*). Mr. A. F. Basset Hull, who recently paid an ornithological visit to the island, tells how he watched the birds from the laying of the egg to the hatching and rearing of the young ones. The important points are these. The White Tern breeds in densely wooded gullies; the single egg is laid in a knot-hole or any slight depression on a more or less horizontal branch; "the sitting bird puffs out its breast-feathers so as to completely hide the egg, depressing its forked tail so as to obtain as secure a hold as possible, and sits with its beak pointing into the eye of the wind, so as to offer the least resistance"; both parents share in the task of incubation and show great caution in rising and settling. Mr. Hull writes:—"I saw the young bird, a ball of black down, squatting unconcernedly on the bare limb while its parents were away searching for food. A week later it was still there, and had then grown nearly as large as its mother, but was still covered with the black down. Its mother flew up, and straddled over it, vainly endeavouring to cover it. There it sat blinking down at us, like a black piccaninny in the arms of a white nurse!"

IMMUNITY OF THE HEDGEHOG.—It is well known that the hedgehog shows a strong immunity to snake-poison, sharing this valuable quality with the mongoose and the pig. Dr. Alex. Strubell has, however, increased our admiration of the hedgehog's constitution by showing that it is relatively immune to the toxins of diphtheria and tetanus. The problem of immunity is one of the greatest difficulty; in this case, for instance, the question arises whether the hedgehog has separate anti-toxins for the different poisons to which it is so resistent, or whether it is simply lacking in appropriate physiological susceptibility ("receptors" as they say). Speaking of immunity to snake bite, reminds me of G. Billard's recent observation that the lerot (*Eliomys nitela*), a kind of dormouse, is immune to the poison of vipers, with which, indeed, the little creature fights fiercely.

BY R. LYDEKKER.

THE AFRICAN BIG GAME FAUNA.—Largely owing to the Roosevelt expedition of 1909, the additions to our knowledge of the big game fauna of Africa during the last few months have been so extensive that it seems advisable to devote considerable space to the subject. It may be premised, however, that our American friends make rather more of these additions than they are really worth, describing as species what ought to be regarded as local races.

Among these new forms, special interest attaches to the description by Mr. G. S. Miller, in Vol. LIV. No. 7, of the *Smithsonian Miscellaneous Collections*, 1910, of a hippopotamus skull from Angola, which is there regarded as representing a distinct species, although it is of course nothing more than a local race of the ordinary hippopotamus, and should be known as *Hippopotamus amphibius constrictus*. From that of the typical *H. amphibius* of the Nile and North-eastern Africa generally, the Angolan skull differs by the more marked flattening of the upper surface, the much deeper lateral constriction behind the muzzle, the shorter union at the chin of the two halves of the lower jaw, and the proportionately smaller size of the cheek-teeth. In the hippopotamus of the Cape, which was named by the French naturalist Duvernoy, so long ago as 1846, and may now be known as *H.a. australis*, the flattening of the skull is carried to a still greater degree, the socket of the eye is peculiar in having its transverse diameter in excess of the vertical, and there are certain distinctive peculiarities in connection with the teeth.

The sable antelope of British East Africa, typified by a female shot by Mr. Kermit Roosevelt, in the Shimba Range, has likewise been described by Mr. E. Heller in Vol. LIV. No. 6 of the *Smithsonian Miscellaneous Collections*, 1910, as a distinct species, but is clearly nothing more than a local race of the typical southern animal, which should be known as *Hippotragus niger roosevelti*. It is described as having the upper parts much lighter coloured than in the typical southern race, only the dark head-stripes, throat, and fore-legs being black, while the general body-colour is light chestnut. There is also a less marked contrast between the dark and light face stripes, the light ones being buffish yellow in place of white. It is much to be desired that the colour of the male should be described, as even in the southern race, most of the upper parts of the female are dark chocolate in place of black, so that the East African form is only a step in this direction towards the original chestnut type still retained in the calf.

Turning to smaller antelopes, the first for notice are two Eastern races of the well-known duikerbok of the Cape, *Cephalophus grimmi*. This southern duikerbok is characterised by the great comparative length of its ears, and is found all over South Africa, where it is represented by several local forms. At its most northern limit, on the west for instance, by *C.g. splendidulus*, of Gray, from Angola; further east, by the Matabili form *C.g. fulvescens*, of Lorenz, which probably crosses the Zambezi into Northern Rhodesia; its eastern representative is *C.g. altifrons*, of Peters (=*ocularis*, Pet.) from southern Mozambique, which ranges south of the Zambezi to Tette and north to the Loangwa River, at least as far south as Angoniland. In the shire Highlands, Mr. R. C. Wroughton, in the *Annals and Magazine of Natural History* for 1910, series 8, Vol. V, page 274, has however shown that these long-eared races give place to short-eared types allied to the Abyssinian duikerbok, which many naturalists class as a distinct species, but which I prefer to regard as a local race of the Southern one, under the name of *C.g. abyssinicus*. The shore race, which on this view will be known as *C.g. shirensis*, agrees in size with the other East African forms but is distinguished by its brighter ochry coat; the general colour above being ochry buff; all the hairs have drab bases, those of the neck and shoulders are ochry buff to their tips, those of the back, shortly tipped with black. Below the colour is the same as in *C.g. hindei*, but much paler.

The second race described by Mr. Wroughton, which may be known as *C.g. hindei*, is from Nyasaland and is specially characterised by its bright colouring. In size it is about the same as the race known as *C.g. nyansae*; and its general colour above tawny ochry, bright on the neck and shoulders, duller on the back and loins, but the yellow tinge is never absent, even on the rump, as it is in *nyansae*; individual hairs of the neck are drab-grey, with ochry tips, but posteriorly the ochre tip becomes a sub-apical ring, and the tip black. The chin and insides of the upper part of the limbs are whitish; the throat ochry buff, with the hairs the same colour throughout, but on the flanks the hairs are coloured like the neck but with drab bases. Mr. Wrightson adds that the grizzling characteristic of the more northern forms is in *C.g. shirensis* so fine and faint that, at quite a short distance, the coat seems to be uniformly coloured, this and the pale bright ochry colouring serving to at once distinguish this race from the others.

THE ZOOLOGICAL SOCIETY.—At the meeting of the Zoological Society of London held on April 5th, Mr. F. E. Beddard read a paper on the alimentary tract of birds, with special reference to the mesenteric relations of the intestinal loops; Mr. R. H. Whitehouse discussed the tail-fin of the bony fishes and their relatives, while Mr. T. M. S. English communicated notes on the frogs of Tasmania.

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MICROSCOPY.

As Microscopy is the hand-maiden to very many branches of Science, it is difficult for one worker to deal with the whole subject, and a suggestion has been followed that a number of those who use the microscope in their studies should be responsible for the microscopical column in KNOWLEDGE. We have pleasure in announcing that the well-known microscopists whose names are given at its head have already promised to help.

ARTHUR C. BANFIELD. NICHOLAS E. BROWN. A. E. HILTON.
WILLIAM C. BARTON. CHARLES H. CAFFYN. RICHARD T. LEWIS, F.R.M.S.
THE REV. E. W. BOWELL, M.A. ARTHUR EARLAND. CHARLES F. ROUSSELET, F.R.M.S
D. J. SCOURFIELD, F.R.M.S. C. D. SOAR, F.R.M.S.

QUEKETT MICROSCOPICAL CLUB. April 26th.—Mr. A. E. Hilton read a paper on "The Life Phases of Mycetozoa." In the life-cycle of this group there are three principal phases—aquatic, amoeboid, and spore-forming. In the aquatic stage the individual swarm-spore is a speck of plasm with nucleus, vacuoles and flagellum, requiring a power of from 300 to 1,000 diameters for easy observation. In the phase which follows, a plasmodium is formed by the fusion of many swarm-spores. Air and moisture are essential to keep the plasmodium mobile. It presently seeks drier places, concentrates, and comes to rest. The organism then passes into the spore-forming stage. The plasmodium is gathered up into sporangia, each sporangium containing very many spores. When the spores become immersed in water the plasm within them expands by absorption, the fragile shells are ruptured, the plasm-specks emerge as swarm-spores and the aquatic phase begins again.

Mr. Hilton exhibited under a microscope active, living swarm-spores × 500.

Mr. James Burton read a note on "Two instances of Breaking of the Meres." "Breaking of the Meres" may be defined as that condition of a body of fresh water when it is so permeated with one or more species of microscopic algae as to be visibly affected by their presence. The instances referred to occurred, one in a small roadside horse-pond near Totteridge, and the other in the Welsh Harp Reservoir, Hendon. The appearances noted were described at length. Both were due to enormous numbers of *Oscillatoria* filaments. The Welsh Harp specimens were identified, with reservation, as *Oscillatoria Agardhii*, the Totteridge specimens are still determinal. Specimens and drawings of both gatherings were exhibited.

NOTES ON PODURAE.—Before the introduction of the high power oil immersion and apochromatic lenses, a common test for a microscope objective used to be its power to resolve the markings on a Podura scale, and the various interpretations of these markings by observers of that time still form interesting reading.

No specific standard, however, seems to have been determined upon as to the kind of scale to be employed for the purpose, except that frequent reference is made to certain scales originally mounted by the late Mr. Richard Beck, which were taken from an insect now assumed to be extinct. Notwithstanding the statement in the Micrographic Dictionary that "the scales of several species belonging even to different genera are exactly similar both in form and markings," it is nevertheless a fact that to speak of a Podura scale as giving any idea either as to shape or size, is much the same as to compare some other object as resembling a potato in size and shape, seeing that not only do the scales vary in appearance, according to the species of Podura from which they are obtained, but those from insects of the same species greatly differ, not only according to the age of the insect, but also according to the part of the same insect from which they are taken. I have before me drawings of no less than seventeen different sizes and shapes of scales procured from a single adult specimen of *Lepidocertus curvicollis*, amongst which those most nearly resembling the Beck scale came from the upper part of the prothorax, immediately behind the fringe of upstanding hairs which overhang the neck; the markings on all of these, however, are similar in character, varying only in number and size. Podurae of this species—apparently synonymous with what used to be called *Podura plumbea*—can be readily kept alive in properly constructed cells for many months, and if suitably fed and supplied with sufficient moisture they will multiply and thrive, as might be expected under circumstances where they have plenty of the society of their own species and are safe from their natural enemies. As microscopic objects, under low powers up to about one inch, few more beautiful insects can be found; when recently hatched they are pearly white, but become darker after each successive moult until in the adult stage they become a deep purple, but in all ages the markings on their scales diffract the light and cause them, as they move about, to flash with all the colours of the spectrum. Having had them under observation more or less during the last fifty years, I have become fairly well acquainted with their habits in confinement, and have traced their life-history from the egg upwards, but have never yet succeeded in seeing how the eggs are laid; but as these are always discovered in the morning in groups of about ten, they are presumably deposited only during darkness, and as each batch exceeds in bulk the size of the largest Podura it can only be inferred that some considerable expansion takes place after deposition.

The use of the curious ventral tube is also still problematical, but I have never seen it used as a means of adherence to smooth surfaces, as has sometimes been asserted; the insects in all stages run about quite freely, and, indeed, frequently sleep in an inverted position on the upper glass of their cells without ever having recourse to what would then, if ever, be of service to them. Under high powers the minute structure of the bifid portion of the "tail," and of the groove in which it rests when out of action, are worth attention.

R. T. LEWIS.

RADULAE AS MICROSCOPIC OBJECTS.—The radulae, or lingual ribbons, of Mollusca form very beautiful objects for the microscope; and they are of interest to the systematic student of zoology. Since some microscopists use their instrument for pleasure, and others for business, some for delectation, and others for the acquisition of knowledge of detailed structure, it is a little surprising that these organs are not more generally studied.

It is not quite so easy to make a good radula preparation as the text-books assume. In some cases it may be a matter of great difficulty, though it is always easy to determine the character and approximate number of the unci.

If the radula is only required for diagnostic purposes, in those cases where there is a known difference to be looked for, the necessary dissection can be carried out without elaborate apparatus. A sharp knife, a pin or two, a clean slip and No. 1 coverglass, and a pocket lens of fifteen or twenty diameters magnification, will enable one to make the extraction at the pond side. The general anatomy of a small *Planorbis* can be readily seen by judicious inclusion between the slip and coverglass, and the odontophore, containing the radula, may be gradually isolated. On adding a very small drop of glycerine or water, and carefully continuing the pressure with slight lateral movements, after clearing away the parts not required, the radula itself is brought into view. It may be

recognised by the diffractive effect which it produces in a medium like water or dilute glycerine. With an anastigmat lens of power × 16 it is just possible to recognise the rows of unci in a small example of *P. vortex*. If we were dealing with species like the *Vitreae*, which have very large radulae, the preliminary dissection could be done without any lens, and the form of the unci could be seen fairly well with the above-mentioned magnifier. On the other hand, the radulae of *Vertigines* cannot well be extracted without the use of a good dissecting microscope. But with the majority of species this preliminary isolation can very well be performed in the field, unless it is desired to make a careful investigation of the tissues which support and invest the radula. The necessary apparatus can be carried in a waistcoat pocket.

Such a radula, on more minute examination, will be found more or less satisfactorily displayed, but it will probably be choked up with cell-debris, and the individual unci will have their outlines obscured, except at the working end of the organ, with an elaborate investment of formative cells. It will save some misconceptions afterwards if we proceed at once to satisfy ourselves that this is the case; which may be done best by fixing the organ as it is in any good fixative—mercury perchloride answers well, as the object need not be kept—and staining with borax carmine. At the end of the few days which this operation involves, we shall be well assured that in order to bring out the true form of the unci some process must be devised to clear away the accompanying cells. For this purpose caustic alkalis have generally been employed; a large number of such substances will answer the purpose; and they should not be used in concentrated solution. Even a weak solution of ordinary washing soda will serve, provided that its disintegrating action is assisted by occasional tapping of the coverglass. It is a mistake to hasten the process by the application of heat, though this seems sometimes unavoidable when the radula has not first been removed from the surrounding parts, as recommended above. Should it be necessary to operate on old specimens hardened in spirit, it is desirable first to allow them to soak in acetic acid for a considerable time.

The caustic alkali method is, however, very far from perfect. If the dissolution of the attendant cells is not fully accomplished, the final results are no better than those which can be achieved by purely mechanical means, *e.g.*, by cautious tapping of the coverglass. A method which sometimes succeeds is to tie the coverglass to the slide, enclosing the partially prepared fresh radula, and to submit the whole to alternate warmings (in a water bath) and coolings, with a fair interval of time between each, finishing the clearance by tapping. But although I have sometimes obtained excellent results in this way, I consider it too lengthy a process for ordinary use. The generally used alkali method has the further disadvantage that it acts energetically upon the supporting membrane, causing it to curl inwards at the edges, and in some species it even attacks the unci; for the material of which they are composed appears to vary in composition as well as in tenuity. Some months ago, therefore, I resolved to try digestion methods. On the whole, the best results are obtained with trypsin. It is necessary to add a minute proportion of sodium carbonate, so that the digesting fluid (about two per cent. trypsin) plus the object shall be very slightly alkaline; the dead tissue will naturally be acid. The solution containing the object is placed in a small tube, and this is carried in the waistcoat pocket, which here serves as an incubator and agitator combined—as suggested by Dr. Boycott. The process takes some hours, according to the amount of work to be done and the actual temperature attained. The radula is found eventually rolled up longitudinally, like a miniature stair carpet; it is neither hard nor elastic, but can be unrolled and arranged on the slide with the greatest ease; and after a little washing with clean water it will be found quite clear. The membrane will fall flat on the slide, and the side margins, which are of considerable extent, will be preserved.* The relation of the unci to one another is not distorted.

Having arranged the radula on the slide, we proceed to fix it. The most convenient plan is to fasten a wide square temporary coverglass over it with thread, and to place the whole slide in a tube or small bath containing the fixative. Many different fixing fluids may be used with success, but the important point in all is to take care that the process goes far enough. A test may be made on some large form, such as the common snail. The radula of this animal takes about ten times as long to fix as do the softer parts; when the process is complete it should be stiff and opaque, readily taking stain. It will also be found, when metallic salts are used as fixatives, that although the object is rendered transparent in the process of clearing, it nevertheless does not become invisible in Canada-balsam, even if no stain has been applied. If the aceto-bichromate mixture is used for fixing, it need not be completely washed out, since it leaves a stain which is not obtrusive, and yet photographs well on an ordinary plate. After fixing, stain if necessary, dehydrate, clear, and mount in xylol balsam.

The accompanying figures were taken with a vertical camera and diffuse daylight. They will serve to illustrate some of the points mentioned above.

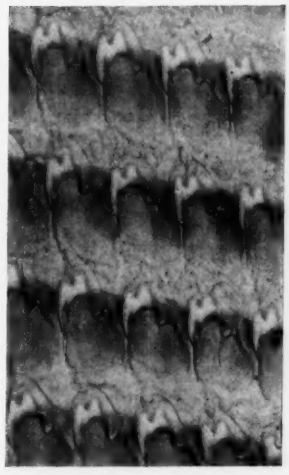


FIGURE 1.
Part of the radula of *Helix aspersa* showing a group of the external unci.

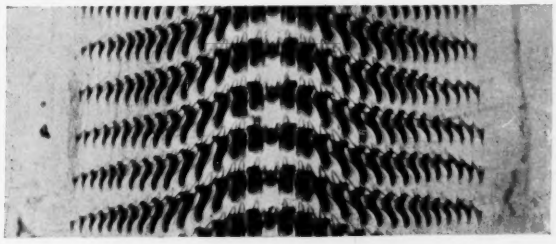


FIGURE 2.
The radula of *Vitrea cellaria* showing the whole width of the important membrane.

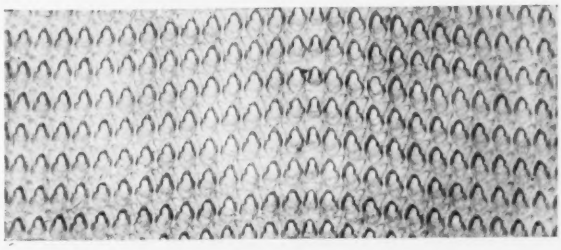


FIGURE 3.
Part of the radula of *Helix aspersa* showing the central and admedian unci.

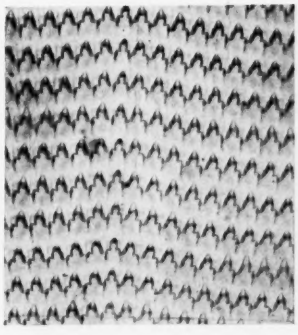


FIGURE 4.
Part of the radula of *Agriolimax agrestis*. The points of the unci are alone in focus.

* This is of especial importance in the Genera *Planorbis* and *Ancylus*.

Figure 1 shows a group of the external unci of *Helix aspersa*. The specimen has been fixed after insufficient treatment with caustic alkali. It has been lightly stained with Mayer's cochineal tincture to bring out the forms of the basal-plates, but these are not in focus in the photograph. Round the unci are seen enclosing lines, which roughly follow their contour; these are the investing cell systems, rendered structureless and transparent by the action of the alkali. In less favourable examples they often entirely prevent the form of the unci from being seen. They occur throughout the radula, except on the parts actually in use. The irregular lines between the rows of unci in this example also represent cell-structures imperfectly cleared by the alkali. The digestion method entirely removes these obstructions. In the case of a large species like the present they may be unimportant, though certainly they have the effect of distorting the view; but in general like *Ancylus*, *Pupa*, and *Physa*, their presence gives rise to seriously incorrect interpretations.

Figure 2 shows the whole width of the radula and its supporting membrane in *Vitrea cellaria*. This specimen has been digested, fixed, and mounted as recommended above. The dark stain of the basal-plates is due to bichromate. The distinctions between this and the closely allied species are well seen by this method. The preparation itself and the original negative showed very clearly the origination (?) of the rows of unci in longitudinal folds of the supporting membrane.

Figure 3 shows a tract of central and admedian unci in *H. aspersa*. No objective giving good definition can image the basal-plates and unci at the same time, since they are about thirty micra apart. Consequently, if a print shows them both at the same time, one or other must be distorted, and evidences of spherical aberration will be observed in the picture. In this case however, the double record has been secured by making two exposures on the same plate, by moving the graduated head of the fine adjustment during the exposure, to an extent previously determined. There is naturally a little falling off in the clearness of the images so obtained, the plate as a whole being over-exposed; but they serve to exhibit well the symmetrical appearance of the object.

Figure 4 shows a similar portion of the radula of *Agriolimax agrestis*, in which the points of the unci alone are in focus. In some places the basal-plates are faintly seen, but these glimpses give no idea of their real shape and dimensions.

E. W. BOWELL.

PHOTOGRAPHY—PURE AND APPLIED.

By CHAPMAN JONES, F.C.S., F.I.C.

THE ACTION OF CHARRED WOOD ON PLATES.—D. Isitani finds that wood, which at the ordinary temperature scarcely affects a plate when placed almost in contact with it for seven days, gives a very distinct image if it is charred. Ordinary wood charcoal is not active. It would appear probable that the heating drives outwards the active constituent, resinous bodies perhaps, and thus causes a more rapid action. In the charcoal itself such substances would of course be destroyed.

THE COLOUR SENSITISING OF PLATES.—The difficulty of sensitising a few plates at a time as the photographer needs them, is chiefly a matter of drying them after the bathing, as it is but few who have a drying chamber through which a current of filtered air can be drawn. Professor Valenta proposed to use baths containing alcohol or acetone, 40 to 50 per cent., to facilitate the drying, but Professor Namias finds that plates so sensitised are inferior, and if the drying is hastened by putting the plates in a box in which the air is dried by means of chloride of calcium, objectionable markings sometimes occur, even when the plates have been washed for half-an-hour after bathing them. Professor Namias claims to have successfully obviated these disadvantages. In absolute darkness the plates are put into the prepared sensitising solution and allowed to remain for fifteen minutes instead of the usual two or three minutes. They are then transferred to a large tank of plain water or washed for a few minutes in running water. After this they are put into 95 per cent. alcohol for a minute, and finally removed to a box containing chloride of calcium. In two or three hours they will be dry ready for use. The alcohol may be used several times. The full text of this paper, including formulae for two baths, will be found in the British Journal of Photography Colour Supplement for April. The drying of small quantities of material in boxes containing such desiccating agents as calcium chloride, or lime, is a very old and convenient method. The large cubical tin boxes such as are used for biscuits or other foods I have found very suitable for this purpose. A lid with deep sides to slide on can be easily made of stiff brown paper. If a wooden box is available it should be lined with brown paper to render it light tight, and it is advantageous to have a shelf of wire gauze, resting for example on four projecting screws, upon which to place the dish containing the drying material, as the drying takes place more quickly when the dryer is in the upper part of the vessel. It may be worth while, under certain circumstances, to be able to lock the box.

THE EFFECT OF THE COLOUR SCREEN ON DEFINITION.—Before special lenses were made for photographic work it was necessary to use ordinary achromatic combinations constructed to give the best visual results. Such lenses did not "work to focus," as the focus of the most brilliant light, yellowish green, did not coincide with the focus of the light that was most active on the plate, blue and violet. In many of the lenses that were at first specially made for photography this want of coincidence remained, and was compensated for, though not very satisfactorily, by a displacement of the focussing screen. Eventually, lenses were, as a matter of course, always made or intended to be made so that the photographic and the visual images were produced in the same plane. This method of correcting the colour aberration still remains, though improved in degree since the Jena glass factory has provided a greater assortment and more useful qualities of glass. Apochromats, in which the outstanding colour is so much reduced that for most practical purposes it may be regarded as eliminated, are hardly known except in the form of microscope objectives.

The old idea was that the blue end of the spectrum did the photographic work, and in the construction of the photographic object glass made for the great Lick telescope, the same principle was acted on, though in this case the visual image was neglected, and the correction for the "photographic" image perfected at its expense. But if now we utilise the sensitiveness of plates to green and red, and use colour screens to reduce the action of the blue, the colour that is most active on the photographic plate is no longer the old "photographic rays," and the colour correction of the lens may, and almost certainly will, be grievously interfered with. Under these conditions many a good lens will not "work to focus," and the best image that it will give is inferior in sharpness of definition, because it was not constructed to be employed in this manner. If it is really intended to make the photographic values of various colours equal to their visual values, then the chromatic correction as effected for merely visual purposes would be the best for photography. But when the coloured screen necessary to reduce the excessive action of the more refrangible light was removed, such a lens would not work to focus. If what is commonly called monochromatic light is used, that is light from one small part of the

spectrum only, then, whatever method of colour correction has been adopted in the lens, or even if it is not corrected at all, the visual and photographic image must coincide. By excluding in this way the light that causes the aberration, an ordinary achromatic lens will give as good results as an apochromatic lens so far as colour is concerned. The best colour to use for this purpose is that which is made the best of in the correction, that is, in the lenses made for visual use, the yellowish green. It is unfortunate that no satisfactory green screen can be obtained that will stop all colours except this. The next best is the full green that is commonly used in microscopy. But the main thing to bear in mind is that achromatic lenses cannot be corrected so as to give equally good results under divers conditions, and that the quality of the colour correction, and of course this means the sharpness of the image, will be affected more or less by any alteration of sensitiveness in the plate, and any change in the colour of the light that is used. A little consideration of any given set of facts in the light of fundamental principles, will soon indicate in what direction to work.

SOLAR DISTURBANCES DURING MARCH, 1910.

By FRANK C. DENNETT.

DURING March spot disturbances have again been few in number, only the first being of notable magnitude, but the disc has never been free from spots. There has been a considerable amount of faculae, and some large prominences. The central meridian at noon on March 1st was 15° 8′.

Nos. 16 and 19 were in part still visible until March 1st and 2nd respectively, and so appear on the present chart.

No. 19A.—A group fifty thousand miles in length, consisting of a considerable spot, with pores behind it, broke out suddenly 10° west of the area where No. 19 had died out. The faculic disturbance covered the entire district. Seen 4th till 6th, passing round the limb.

No. 20.—A small active disturbance, a larger pore, with smaller ones eastward, about twenty-six thousand miles in length on 1st. By next day there were two spots, each fifteen thousand miles in diameter, with pores between. The following spot increased in diameter to twenty thousand miles and the length of the group to eighty thousand. The inner edge of the penumbra of both spots was bright fringed on 3rd and 4th. Last seen close to limb on 8th. Accompanied by aurora on 1st.

No. 21.—On 4th two minute pores twenty-nine thousand miles apart showed in the south-eastern quadrant, the western one continuing visible until 5th.

No. 21A.—A microscopic pore in a faculic disturbance estimated to be in the position shown, but too delicate for accurate measurement. Only seen on 7th.

No. 22.—A group opened on 8th, which by 10th had become a triangle fifty-two thousand miles in length, but the members were all small, and died out after 13th.

No. 23.—A return of No. 13, but in altered form, all the former area being now covered by faculae. When first seen on 10th there were three spots nearly in line, the most southerly one being a little ahead of the others, the line being nearly fifty thousand miles north to south. The southern spot fell behind the line by 14th, when a pore had appeared following the larger middle spot. By 15th bridges crossed each of the umbrae, and pores were formed eastward of the two northern spots, with one well to south of the southern one. On 16th a fourth small spot had broken out east of the middle one. By 17th this last and the northern spot had gone. The two southern spots only were seen 18th, 19th, and the larger one only 20th-21st. The largest—middle—spot had the inner edge of the penumbra bright fringed on 17th, 18th and 20th.

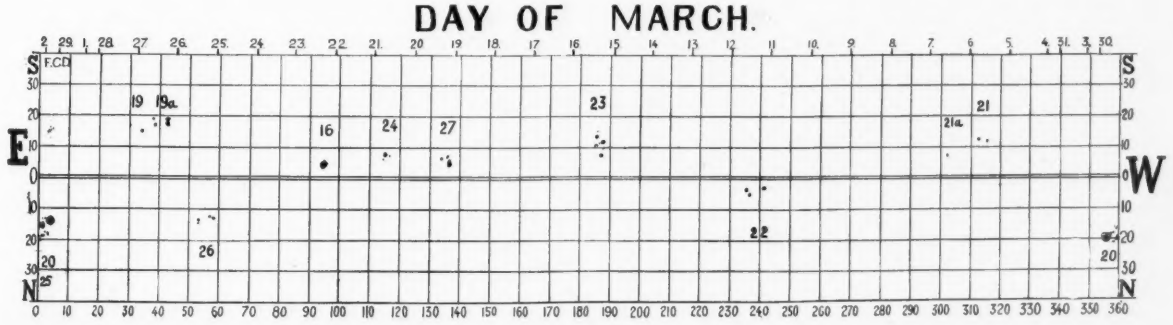
No. 24.—A small spot, six thousand miles in diameter, the return of No. 16a, situated on the western boundary of an immense faculic area extending from the equator southward for nearly one hundred and ninety thousand miles. As this region came round the limb it was seen to be covered by an immense heap of prominence matter 30″, or two hundred and twenty-seven thousand miles, from north to south, and forty thousand miles in height. It was on the limb 16th, 17th, and 18th. The area included the site of No. 16. The spot first seen 15th had its umbra crossed by a bright bridge 17th—20th, with pores west and north on 17th and 19th, a triangle north 18th, east and west, fifty-two thousand miles apart, 20th and 21st, when there was also another, south. The spot had dwindled to a pore in a coarsely granulated area 22nd-23rd, when last seen.

No. 25.—A spot twelve thousand miles in diameter, the remains of No. 20, seen again 24th. The umbra was crossed by bright bridges, and its penumbra had the inner edge bright fringed on 27th and 30th. When first seen it was followed by an extensive faculic disturbance over and beyond the district formerly occupied by the spot group. In this, thirty-eight thousand miles north-east of the spot, a black pore was visible 25th-26th. As it neared the central meridian pores broke out directly east of the spot on 28th, not seen next day, but three were again visible 30th-31st, in a very disturbed looking area. On and after April 1st the faculic disturbance again became visible, the spot dwindling until last seen on 3rd. Bright auroral displays were recorded 28th and 29th.

No. 26.—A group consisting at first of a spot ten thousand miles in diameter with a multiple umbra, and a line of three pores, the whole being twenty-six thousand miles in length. Only pores seen after, but the length increased to forty-four thousand miles. On 28th, when last seen, the pores were almost microscopic.

No. 27.—A small spot, with pores south and south-east, developed in a faculic district a little west of the area where No. 24 had been situated. It was very near to the western limb, and so only seen on the one day.

The chart is constructed from the combined observations of J. McHarg, A. A. Buss, E. E. Peacock and F. C. Dennett.



CORRESPONDENCE.

THE GAME OF COMET.

To the Editors of "KNOWLEDGE."

SIRS,—I recently came across the following explanation of why the Nine of Diamonds came to be called "The Curse of Scotland," and I should be very glad if any of your Readers, whether Astronomers or Historians, could inform me whether there is any foundation for this statement.

In the middle of the Sixteenth Century there was popular in Paris a game of cards called *La Comète*. It was introduced into Scotland by some of the French Attendants who went thither from Paris in the retinue of Mary, Queen of Scots. It was at once taken up by the Scotch nobility and gentry, and became exceedingly popular, so much so that it led to a great deal of gambling, culminating in large borrowings and mortgages of estates. As the Nine of Diamonds was the Trump Card of the game, so it came about that particular card was regarded as a curse to Scotland.

I have succeeded in discovering from French sources of information, that such a game used to be played in France, but I have not been able to connect it with Scotland in the terms of the above statement.

Your obedient Servant,

ASTRONOMICUS SCOTICUS.

CARBON IN THE SUN'S VICINITY.

To the Editors of "KNOWLEDGE."

SIRS,—Referring to Mr. Allison's letter in your current issue as to the possibility of the space near the sun being filled with gaseous compounds of carbon at low pressures, Mr. Newall, in his Presidential address to the Royal Astronomical Society for 1909, and elsewhere, attributes the cyanogen bands as found in cometary spectra to the presence of matter in the circumsolar space, rendered incandescent by some processes connected with the motion of the solid parts of the heads of comets, or with the emission of some influence therefrom. The spectra of all comets are approximately similar, because they always find the same vapours in their path as they approach the sun. The luminosity he supposes to arise when small specks of cometary matter are rushing through the gases. "If one admits radiation pressure and the phenomena of the repulsion of comets' tails, one is driven to admit the existence of vapours and gases in circumsolar space."

There are no doubt difficulties, but the great extension of the corona shows the existence of matter in considerable amount at a distance from the sun, though questions of resistance produced by such matter, and the possibility of its existing in equilibrium, remain unsolved.

Yours truly,

F. W. HENKEL.

NEWTON ON THE EARTH'S MOTION.

To the Editors of "KNOWLEDGE."

SIRS,—There is an edition of Newton's Principia which was published at Rome, in 1742, by the Jesuits Le Seur and Jacquier. This is known as "The Jesuits' Newton," and it is a most valuable work, full of mathematical notes and comments. I have a copy which was published in Glasgow in 1822. It is but little known now.

In their preface the learned Jesuits make the following remarkable statement, which I translate from the Latin in which it is expressed: "Newton in this third book assumes the hypothesis of the Earth's motion. The propositions of the Author cannot be otherwise explained than by this same hypothesis. Hence we are compelled to assume a character foreign to our own. However, we profess to comply with the decrees promulgated by the Supreme Pontiffs against the Earth's motion."

In view of the correspondence about the treatment of Galileo, the above remarkable pronouncement may be of interest to the readers of "KNOWLEDGE."

Yours truly,

G. M. MINCHIN.

149, BANBURY ROAD,
OXFORD.

It is hoped that in future numbers, a query column will be instituted.

REVIEWS OF BOOKS.

Progressive Redemption.—By the REV. H. E. SAMPSON.

(London: Rebman. Price 12/6 net.)

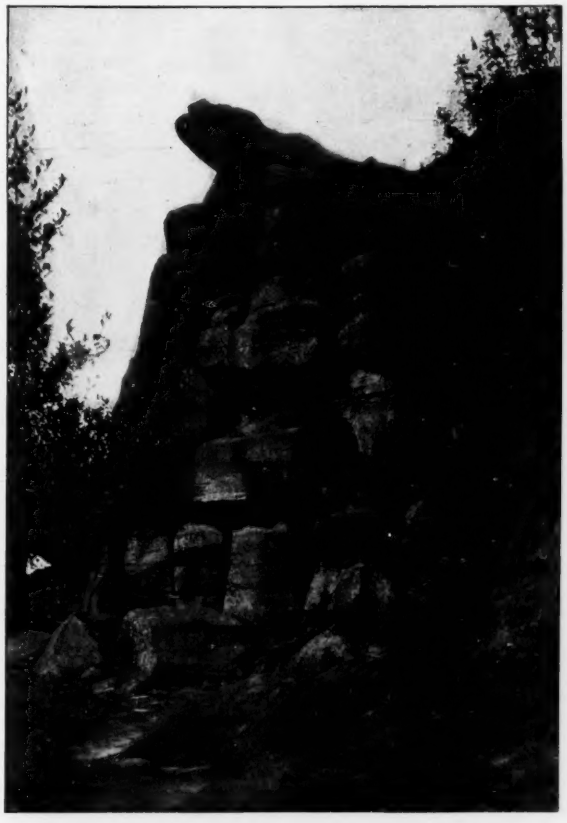
In Progressive Redemption, the Rev. H. E. Sampson pursues the train of thought outlined in Progressive Creation, the two volumes of which have already been reviewed in these columns. The intention of the work as a whole is to present a synthetic philosophy which shall cover the processes of creation and evolution, both as we know them, and as we may suspect their end and aim to be. For example, he considers the phenomena of evolution in their incompleteness and compares it with a philosophical interpretation of what we may describe as the purpose of evolution. In many respects, evolutionary forms are incomplete; there are instances of arrested development; there are apparent instances of failure of type. Therefore, argues Mr. Sampson, we are justified in supposing that the phenomena of evolution represent an interruption of some settled order of progression. They are the steps by which the created life of the world is making its way back to a higher and more spiritual state of being. The true order, and the true aim, is the progressive creation of beings who, as in the Buddhistic belief, pass by successive re-incarnations from lower to higher types, culminating at last in perfect Godhood. In amplification of this theme, which is very ingeniously and attractively stated, the reverend author has cited the hidden allegories of Biblical story, and has shown how much of the mysterious symbolism of the neglected science of the astrologers and the dimly comprehended maxims of the Rosicrucians is appropriate to the theory. The Author's intention and purpose are explicit and clear, and even to those who cannot follow him in his speculations, his wide knowledge of symbolism and its relativity will make this volume very interesting.

The Dates of Genesis.—A comparison of the Biblical Chronology with that of other Ancient Nations with an Appendix on Chronological Astronomy.—By the REV. F. A. JONES.

(London: Kingsgate Press. Price 5/- net).

This can hardly be described as a book forced into being by the urgency of supplying a long-felt want. We have for so long been accustomed to regard a large proportion of the actual numbers given in the authorised version of the Bible as of very little importance, that it seems strange that anyone should now set out to champion the literal accuracy of the ages given in Genesis. A good many years have elapsed since Alexander Hamilton, a competent Sanscrit scholar in the employment of "John Company,"

produced a work contending for practical identity between Hebrew and Hindu dates. This work is acknowledged by Mr. Jones to have been the original source of his inspiration, and the acknowledgment is borne out by a comparison of the two works. The author claims credit for originality, however, in some instances, besides that manifestly due to one who compiles for the general reader information from little-known sources, so we will consider rather more closely these portions of the book. We cannot forbear to remark, in passing, that the title of the book is unsatisfactory from a literary point of view, a curious use of the word "other" implying a somewhat "free" interpretation of "Biblical." One of the special claims to originality is that a fresh argument is adduced on p. 105 to prove that of the two suggested dates for the construction of the Great Pyramid, 2170 B.C. and 3400 B.C., the former must be right. There is a great want of lucidity in the book here, as we cannot see that the argument as stated proves anything at all, let alone the "astounding conclusion" of the author, that a lateral "displacement" of the passage in the north side of the Pyramid *proves* that the builders "were fully cognisant of the revolution of the pole of the earth round the pole of the ecliptic, and of the *nature* of the phenomenon of precession." He quotes a letter of Sir John Herschel in which the word "westwards" is used to describe the position of the pole with reference to Alpha Draconis at the time of the construction of the Pyramid, and he makes a good deal of fuss about the pole having been to the westward of Alpha Draconis. But it is obvious that no star can be anything but south of the pole, except by virtue of daily rotation passing through all points of the compass, therefore he must have misunderstood Herschel's comment, which is to the effect that the then position of the pole lies to the westward, *as we should now call it*, of Alpha Draconis, meaning, of course, in reference to the present position of the pole, a line from which to the old position would pass to the westward of Alpha Draconis. Moreover, we fail to see that "a line from the centre to the entrance of the passage makes the *exact angle* 3°42′" in the absence of any evidence that the length of the passage is exactly equal to half the side of the base of the Pyramid. Perhaps readers who are fond of puzzling out obscurities will find entertainment here, and may prove the validity of Mr. Jones' contentions. But we have dwelt too long on this point, which can hardly be taken as typical of the research necessary to the production of the book. We think the author labours too persistently on "Noah, the eighth person," by straining a perfectly well-known Greek idiom for "Noah with seven others" (viz., his three sons and his and their wives), to mean that Noah was the eighth ruler from Adam, and thus set up an imaginary difficulty in regarding Enoch as "The seventh from Adam." We fail to follow a good deal of the astronomical chronological appendix, with its minute calculations based on a 360-day year. But it may be that there is a public which will welcome the book and to them we leave it for full consideration.



From a photograph by *Godfrey Bingley.*

Jointed Sandstone, Brimham Rocks.

From "The Book of Nature Study."

The Book of Nature Study.—Volume VI. Edited by PROFESSOR J. BRETLAND FARMER, F.R.S.

(London: The Caxton Publishing Company. Price, 7s. 6d. net.)

Perhaps no greater praise can be accorded to the present volume, than to say that in every respect it is equal to the five volumes that have preceded it. In many respects, owing to the greater breadth of the subjects treated, it will prove more generally acceptable than the volumes dealing with somewhat sharply defined and specific subjects. Weather and Climate, for instance, appeal to all, and the student who conscientiously studies the chapters devoted to this subject in the wider sense, will clearly understand the relations between vegetation and precipitation, and the cause and influence of snow, ice, and so on. The various forms of clouds are beautifully illustrated, and their origin is clearly explained in terms strictly accurate, and at the same time readily grasped. Many points in connection with the apparent movement of the sun, day and night, and the seasons, that have not previously been clearly understood, or have been entirely ignored, are explained in such a lucid, yet simple, manner that the information is acquired unconsciously owing to the interest aroused in the subject. The portion already noticed is included under the general heading of "The Physical Environment and Meteorology." The remaining portion comes under "The Physical Environment and Geology." Denudation first occupies attention, and the gradual wear and tear of the earth's surface is fully explained by reference to such everyday subjects as cart roads, garden paths, and rivers. The sequence of geological formations, the various kinds of rock composing the crust of the earth, along with geological and contour maps, also receive attention. The book concludes with an excellent account of the "History of Landscape," "The Growth of Britain," and "Landscape, Population, and Occupation."

The numerous whole-plate illustrations, and figures in the text, help greatly towards a clear grasp of the problems discussed.

A very full general index to the six volumes which, from a series of tests, proves to be very accurate and exhaustive, concludes the Volume.

In the Abstract. by NORMAN ALLISTON, translator of "The Reflections of Lichtenberg."

(London: Swan Sonnenschein & Co. Price 2s. 6d.)

A book with this title does not lend itself to comprehensive consideration from the point of view of a single science such as astronomy. But the author has divided his subject into sections, the first two of which have astronomical titles. We may, then, come to some sort of decision as to this part of the

work and, perhaps, spare a word or two for the general scope. The list of headings is interesting and may be given in full.

1. The First Law of Motion.
2. The Planetary Distances.
3. The Negative Complementation of Colours.
4. The Principles of Correlation.
5. Materialism.
6. A Question of Time.
7. Survey of Invention.
8. The Value of Things.
9. What we Learn.

In regard to (1) we gather that Newton was a great thinker, inasmuch as he was not satisfied to take for granted things generally regarded as obvious. But according to Mr. Alliston he was far too easily satisfied after all, and he takes exception not to the accuracy of the much-discussed Third Law of Motion, but to the First. But does he shake Newton from his pedestal? Words are a very inadequate mode of expressing mathematical and physical ideas, and, as usual, the author finds himself obliged to use a great many words, not "full of sound and fury, signifying nothing," but certainly wearisome. To his suggestion that a body can have no motion in the absence of gravity, and that if a body could move at all there is no reason why it should remain at rest, we would reply that a perfectly free body subjected to no force will not move because of the principle of symmetry, no direction being more likely tnan another; force, however small, is necessary to determine direction. But, says Mr. Alliston, if you hit a ball it will come to rest when its motion is exhausted. We say it will come to rest when friction and other resistances have caused it to do as much work as will balance the energy initially imparted. In the absence of these resistances, energy, once imparted, cannot be dissipated and motion will continue *uniformiter in directum*," as Newton has it, because deviation in any direction will require a bias. Mr. Alliston's reasoning seems to satisfy him, but it leaves us hungry. The second essay is based on a quite fictitious importance the author professes to attach to Bode's Law (so-called). As a mnemonic, the law has its uses, and it cannot be denied that its empirical employment was in a slight degree effective in predicting minor planets and Neptune, although the degree in the latter case was *very* slight and the test unsatisfactory. We must confess to feeling greater interest in some of the later essays, in particular in the Survey of Invention, and we think open-minded readers who are looking for a new point of view will find much food for reflection in them.

A New Algebra, by S. BARNARD and J. M. CHILD.

(London: Macmillan & Co. Price, 4s.)

This work is divided into five parts, of which four are contained in the present instalment; it is intended for school use. The general scheme of the book pleases us. The treatment of irrational numbers is itself very rational. There is a chapter on maxima and minima, a good introduction to graphical methods, and a great number of examples with answers. A key is in preparation. The several parts can apparently be obtained separately—at least, we have received Part IV. in a separate binding.

The New Physics: Sound.—By JOSEPH BATTEEL.

(Middlebury, Vermont: American Publishing Company; London: A. F. Bird. Price 6s. net.)

This seems to be a condensed and expanded version of part of a previous volume by the same author, viz., "Ellen; or Whisperings of an Old Pine." We miss, however, the pictures of Vermont scenery which gave considerable interest to the former treatise. This now endeavour appears to have been written in the interval between "Ellen," and the first volume (1,100 pages) of the American Stallion Register; for Mr. Battell is an authority on horses and their pedigrees; five other volumes of this Register are yet to appear. We gather from the notices at the end that he can tell you just what you want to know about Ben Snatchers and can convey very interesting information about old Copperbottom. But we cannot make head or tail of the book before us.

NOTICES.

A NEW ELECTRICAL INSTRUMENT.

A new instrument for Electrical Engineers is now being manufactured by Messrs. Isenthal & Co., of 83, Mortimer Street, W., namely an Aperiodic Precision Millivoltmeter for continuous and alternating current. It has many advantages over the instruments at present in use and it is claimed that there is perfect accord between scales for alternating and continuous current, besides which the apparatus is independent of periodicity and wave shape of alternating current. Outside magnetic or electric fields do not affect the instrument in any manner and it is capable of taking the most accurate measurements from one ampére up to the highest readings with constant drop in the shunts. The reliability of the calibration and the zero adjustment are the same as in moving coil instruments for continuous current, and the consumption of energy is extremely small. Messrs. Isenthal & Co. are also makers of other interesting scientific and electrical apparatus which we hope from time to time to describe in our columns.

THE SUBJECTION OF BACTERIA.

Our readers will be interested to hear of a new preparation to allay the dust that is prevalent in libraries, museums, class-rooms and laboratories. Any device by which it becomes possible to keep the germs of putrefaction and disease from floating about in the air, is to be welcomed and we understand that "Florigene" weights the dust not only during sweeping but also throughout the intervening period and its action continues for from two to six months according to the wear to which it is subjected. The use of any medium containing moisture is obviated and if necessary the floors can be cleaned every day with an ordinary broom.

LECTURES ON SCIENCE.

Lecture Agencies are of great assistance to those societies who look for the delivery of addresses by others than their members and there are many lecturers who are able to create an interest in the various branches of science with which they deal. We are therefore very pleased to see an advance copy of the book which will be issued by the Universal Lecture Bureau of 32, Sackville Street, Piccadilly. In it we notice some well-known names like those of Dr. William Martin, the authority on treasure trove; of Mr. Charles Welch, until lately Chief Librarian and Curator of the Guildhall Library and Museum; of Christopher Pilkington, War Correspondent; and of Miss E. L. Turner, F.L.S., many of whose charming photographs of birds are reproduced in the book. The North American Indians are gradually dying out, and the lecture which Miss A. L. Handley has prepared dealing with her own experiences among the people, their folk lore and their music, promises to be very attractive. She will be assisted in her vocal illustrations by Mr. George Read.

XUM

A British Wild Cat and her Kittens.

The latter were bred by Mr. Alfred Heneage Cocks, M.A., F.S.A., F.Z.S., and the photograph was originally taken by Messrs. Lascelles & Co. to form the frontispiece to "Eton Nature Study," the two parts of which Messrs. Duckworth & Co. have just issued in one volume. (See page 237.)

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